Air Repair

Recent View of Pittsburgh's Clean Golden Triangle
—Fairchild Aerial Survey

AIR POLLUTION CONTROL ASSOCIATION

4400 FIFTH AVENUE **PITTSBURGH 13, PA.**

Founded 1907

Air Repair

A QUARTERLY JOURNAL DEVOTED TO AIR PURIFICATION

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The Editor welcomes writers interested in Air Pollution problems and encourages them to use the pages of this magazine for the expression of their opinions. But neither he nor the Association assumes responsibility for the validity of these opinions.

JOURNEYS AROUND BRITAIN

by ARNOLD MARSH, *General Secretary*
National Smoke Abatement Society, London

THIS IS GOING to be more of a rambling travel diary than a straight report on what we are doing in Britain. This may or may not make it more interesting and enlightening to read, but it will certainly be more enjoyable to write.

First, though, it is necessary to explain the Divisional set-up of the National Smoke Abatement Society. Our membership is divided into geographical areas —Scotland, North East England, North West, Yorkshire, and so on—and the members in each Division elect among themselves representatives to the central Executive. In six, so far, of the areas the members have formed Divisional Councils, each with its own chairman, and honorary secretary. Subscriptions are all paid to the national body, which makes modest grants as they are required to these Councils for their own activities.

These consist largely of meetings in different towns in the area—which apart from other benefits being useful press publicity—and visits to industrial works or research establishments of special interest. As General Secretary of the national organization I aim at attending a meeting, at least once a year, of each of the Divisions. It is good to keep in touch with members one might not otherwise see—and always useful for one's perspective to get away from London now and then.

From the other side of the Atlantic Britain may well seem to be the tight little island it has been called, but the six journeys to be sketched add up to around 2,300 miles of rail travel and quite a few days away from the office desk and an "In" basket that overflows only too rapidly.

So, after this preamble, the diary of the past few months' excursions.

16th April To Lincoln, for the first meeting of the East Midlands Division to be held in this ancient city of the Fen country, where the great cathedral, set high above the town, can be seen for miles across the smooth plain of cornfields, pastures and farmsteads. On the train met T. Henry Turner, who is to give the address at tomorrow's meeting. He is Chief Metallurgist to the research department of British Railways, a leading authority on the corrosion of metals, and one of the Society's keenest individual members and propagandists. Staying at the same hotel, the Saracen's Head, a rambling but comfortable modernized old coaching inn. After an excellent dinner, which really called for a more gentle stroll, he took me out exploring, by way of what is correctly called Steep Hill, to find and inspect by lamplight the only Roman arched gateway in the country that spans a main, traffic-used road.

Lincoln's air pollution is quite moderate — some engineering industries, railways, and of course our ubiquitous tarry domestic smoke—but the Cathedral stone shows many signs of decay and erosion accelerated by sulfur acids in the air, and members assembled next morning to inspect it. Interest however soon tended to become more general, and there was something very friendly and engaging in the sight of our party, some far from young and slim, toiling in single file up the narrow spiral staircase of the 271 foot central tower—the loftiest medieval tower in England—to admire a magnificent view in what (except for just below us) was clear and smokeless air.

After lunch, with the Mayor and Sheriff as our hosts, came the meeting proper in the old Guildhall, with Turner's excellent paper following formal business matters.

29th April Rendezvous today very different from Lincoln—namely, Stoke-on-Trent, hub of the Potteries. This is now the official name of a city that includes the Five Towns made famous in the novels of Arnold Bennett. A morning meeting in one of the Town Halls (yes—they seem to have more Town Halls than they need), then a pleasant civic lunch, and finally our trip to the fine new building of the British Ceramic Research Association. Laboratories were inspected and even the most ignorant of us could appreciate the importance of what was being done. Of special interest were charts and test records showing the success of research into the prevention of smoke from the most difficult kinds of

Old-style beehive kiln. These are being rapidly replaced by continuous kilns using gas or electricity. The Potteries, England.

coal-fired kilns. A short but vigorous talk by the Director, burly, philosophically-humorous Dr. A. T. Green, who emphasized how the fast-increasing use of electric and gas-fired kilns is notably diminishing the once-notorious smoke of the Potteries. True; there is fine progress being made in Stoke, though there is still plenty of work ahead.

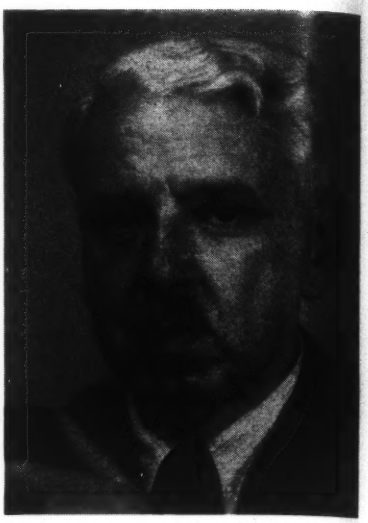
15 May To a North West Division meeting in Manchester. Historically important as the first meeting of the Society to be held in a smokeless zone. Manchester had declared its central area a smokeless zone on 1st May, and as the proposal was conceived, developed, and advocated by the Society it was very satisfying to be at this meeting. The area is not yet a large one, but it is the most important part of the city. Interested to learn that the change had been made smoothly and with little or no opposition. In fact Manchester seemed stimulated by its distinction, and there was talk of people outside the boundaries of the zone asking why they couldn't be in, too. The press, headed by that great progressive paper, the *Manchester Guardian,* had done much helpful publicity to put the idea across to the public.

It was satisfying also to find a crowded audience at the Town Hall—larger than national conferences of the Society less than twenty years ago—to listen to an authoritative talk by Dr. Albert Parker, Director of Fuel Research Station. This is one of the many sections of the important Government Department of Scientific and Industrial Research. The Fuel Research Station is a great ally in our smoke prevention work, not only by its research on industrial and domestic fuel usage and efficiency, but also by organizing and co-ordinating the systematic recording of atmospheric pollution at stations operated by local authorities throughout the country.

22nd May To Scotland, for the two-day annual conference of the Scottish Division, this year at Perth. First visit to this pleasant, historic Royal Burgh on the river Tay. It is the city of the Fair Maid of Scott's romance, and her house is still to be seen. North and south of the town, where it meets the river, and stretching along its banks are two big open park-like public spaces, where games are played and the citizens stroll in the evening by the river bank, watching the patient fishermen standing thigh deep in the swirling waters. These open spaces are curiously called the North Inch and the South Inch—which gives rise to a joke about Perth being the world's smallest city, being inside two inches.

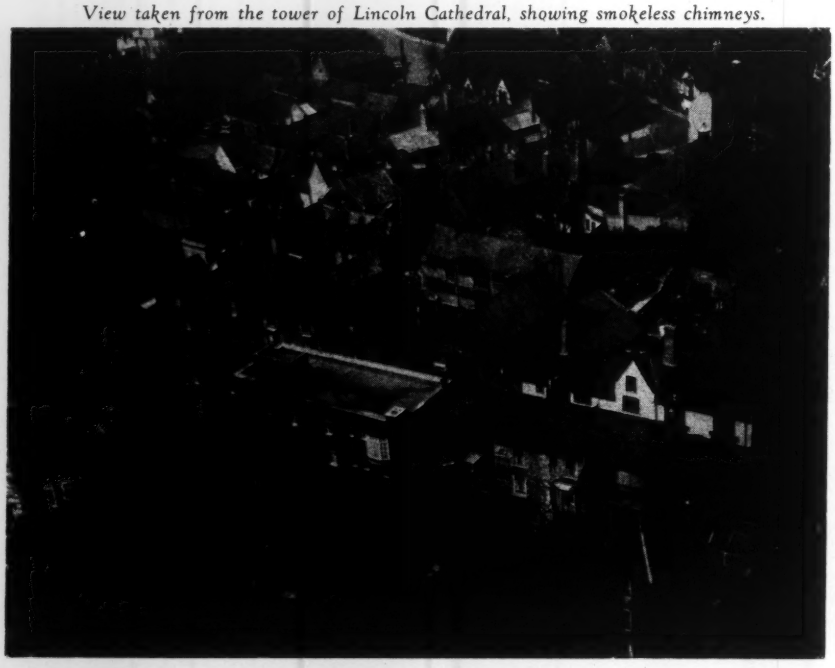
The conference was held in the attractive Art Gallery, of such interest that it needed a sharp stern call from the voice of duty to leave pictures and antiquities and get into place for the official opening of the proceedings and welcome by the Chief Magistrate of the city. Most interesting of the three papers read at this first morning—forenoon, in Scotland—session was on the mobile testing units designed and operated by the Fuel Efficiency branch of the Ministry of Fuel and Power for the testing of industrial plant. The Ministry's engineers have done great work in raising fuel-burning standards, thereby raising productivity, saving coal, and eliminating smoke.

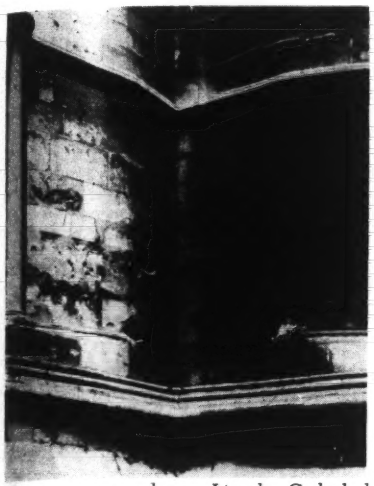
Lunch as guests of the city fathers, and then by motor coach into the hills to Pitlochry to see the new hydro-electric generating station and river dam. This is just one of the many being built by the North of Scotland Hydro-Electric Board,



The Association is deeply indebted to Arnold Marsh for the interest he is taking in our progress. The general secretary and editor of the National Smoke Abatement Society of England is a native of Manchester and was graduated from the College of Technology, University of Manchester, in general chemical technology, later taking a master's degree for his research on the halogenation of coal. He became, in 1928, the first full-time secretary (and for a while the entire staff!) of the Smoke Abatement League of Great Britain in a one-room headquarters office in Manchester. The following year the League amalgamated with the Coal Smoke Abatement Society of London to form the present organization. In 1937, the Society transferred its headquarters to London. Mr. Marsh is the author of "Smoke: The Problem of Coal and the Atmosphere," and of many articles and papers on air pollution. His hobbies include reading of all sorts, walking and gardening, plus, as he says, "an optimistic miscellany of minor pursuits." Some day we'll ask him what that means. He lives at Epsom, Surrey, but race horses are not among his interests. Mr. Marsh is married and has a son and daughter.

View taken from the tower of Lincoln Cathedral, showing smokeless chimneys.





Decaying stonework on Lincoln Cathedral, caused by sulfur in the atmosphere.

to harness the power in the deep lochs and swift streams of the Highlands. No trouble here with smoke, fly-ash or sulfur acids!

The fascinating feature of the inspection was a salmon leap or by-pass constructed alongside the dam. Scotland is a land of salmon, which for thousands of years have made their annual migrations up and down her rivers. For reasons of tradition, trade, and of course, the table, the noble salmon cannot be sacrificed for mere electricity, and so we find a long line of ascending tanks or basins, with the river water flowing down from one to another, making a sort of stairway by which, step by step, the salmon can ascend. One or two tanks are illuminated and through glass walls one can watch the great fish swimming round before finding and forcing their way up through the connecting pipe to the tank above. They are even counted with a photo-electric beam apparatus, which ignores any smaller fish!

The second morning's session brings us a paper by Dr. Stuart Laidlaw, Glasgow's Medical Officer of Health, a comprehensive survey of the effects of polluted air from the viewpoint of health and medicine. A first-class review, with some interesting discussion on the relationship between coal smoke and cancer of the lung—a consequence of smoke long suspected and now being strongly supported by important new evidence. To end the conference in the afternoon came the ordeal of a paper by myself, on Smokeless Zones.

However, there was compensation for this before returning to England — a week-end break in the hill resort of Crieff, with long walks among the mountains, and a warm climb to the summit of one of them, Ben Chonzie. A million miles, it seemed, from the towns and cities and their polluted air. But then in Perth again on the Monday, then by sleeping car to London, coming back to earth with a bump, that very day, with a meeting of our Executive Council.

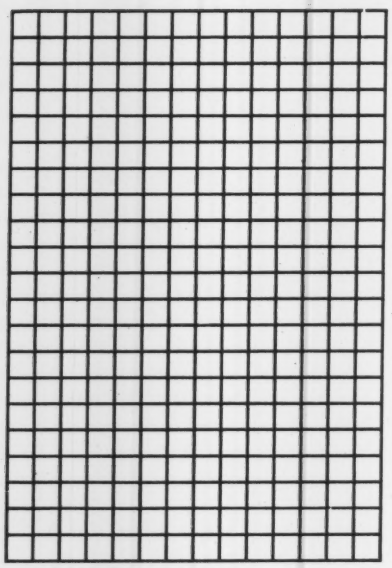
23rd June Again a marked contrast with the last excursion. This time to the steel center of Sheffield, and its smaller neighbor Rotherham, to join the Yorkshire Division in a meeting that was followed by a tour of inspection of the works of the Park Gate Iron and Steel Company —blast furnaces, open hearth furnaces, and rolling mills. As far as pollution is concerned this works seems pretty good, and had a word of praise from James Law, the Chief Smoke Inspector for the area. Sheffield, Rotherham, and other neighbors have joined together to run smoke prevention by a joint committee and a single staff of inspectors, instead of each municipality working alone, as is the case everywhere else. They have one of the toughest jobs in the country, but the Committee has pegged steadily away, not only at smoke inspection and control, but in stimulating research from which good results are coming. Much is due to the indefatigable spirit of Law himself. He seems to have been taken aback a little when the American looked round and murmured: "Just like Los Angeles!"

3rd July To Nottingham this morning, and back home the same night. Another East Midlands meeting, at which I had to be present, being programmed to read again the Smokeless Zones paper. A good attendance in the City's fine modern Civic Hall, and enjoyed the long, critical, and lively discussion that followed the paper. Hard-headed, alert folk, these Midlanders!

Nottingham is a busy, likeable city, with no severe industrial pollution problems. Probably two-thirds of its dirt deposits come from household open fires. But it was here that smoke first came into the records—in 1257, when Henry III, going off to fight the Welsh, left his asthmatic wife, Queen Eleanor, billeted in Nottingham Castle. But the smoke was too much for her, and the historian reports that she had to move to Tutbury. Incidentally Sherwood Forest of Robin Hood still stands, and archery is still a popular pastime in the city — though now, one gathers, they shoot only at inanimate targets and not at Sheriffs. Very dull.

Pitlochry Dam and power station. Note fish ladder in background, and, above it, the clean skies of the Hielands. Scenery reminds one of northern Wisconsin.

Maximilien Ringelmann - Man of Mystery



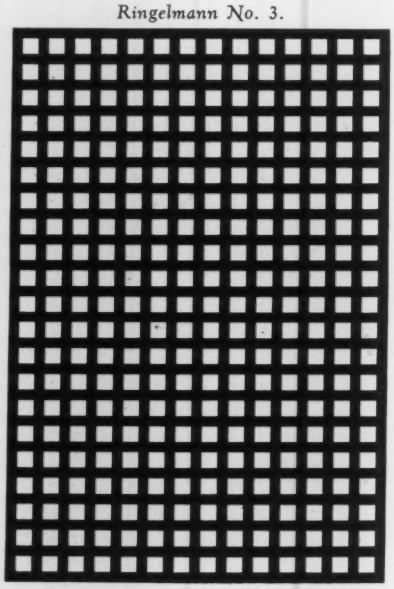
Ringelmann No. 1.

NAMING PROFESSOR RINGELMANN a man of mystery calls for an explanation.

Some mysteries are fairly simple, and this one falls into such a category. It is reasonable to assume, when hundreds of communities are guided by the Ringelmann Chart, invented by the subject of our essay, that quite a bit of information on the famous man would be available.

Surprisingly, there is very little, and practically nothing on his invention of the Chart. Yet Ringelmann was a prolific writer, mostly on subjects of agronomy, for he was a professor of agriculture at the Institut National Agronomique (National Agricultural Institute) in Paris for all of his adult life.

Ringelmann No. 3.



We obtained considerable biographical information from the Institute as well as from the French Embassy, which is herewith passed on to our readers.

Maximilien Ringelmann, who was born in Paris on Dec. 10, 1861, was a scholar at the Turgot Municipal School from 1874 to 1878. He was barely 17 years old when he matriculated at the National Agricultural Institute, from which he was graduated, two years later, the fourth in his class.

At the same time he took a course in the Superior Agricultural School, studying liberal arts evenings, and also took a course under Hervé Mangon, whose scholar he was always honored to be.

From 1880 to 1881, he attended the National School of Roads and Bridges, at the same time perfecting himself in English, German, and Spanish. At the age of 20 he was named instructor in rural science at the National School of Agriculture at Grand Jouan.

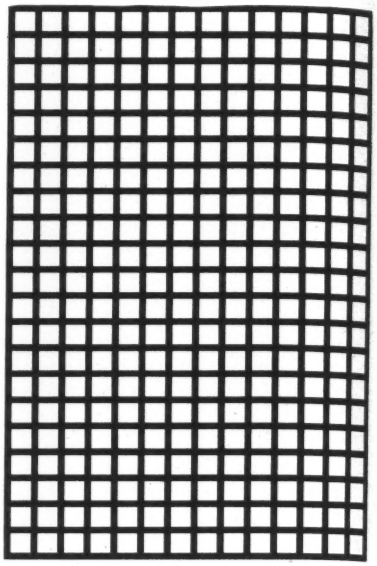
No better choice could have been made. Ringelmann found his vocation and career which corresponded best to his tastes, his aptitudes, and the rest. He prepared before the most eminent masters, and he was admirably favored.

Upon his arrival at Grand Jouan he exposed that which was to be his whole life: possessed of a real desire for experimentation, he gave an account of his thesis of the value of agricultural machines, the quality of work they provide, their performance and their cost.

From this period Ringelmann had a good insight into the role which the machine was called to play in agriculture, also of the transformation of cultural methods which forced new economic and social conditions.

He himself wrote:

"From the very first I have caught a glimpse of machines taking a very important position in the future. I have also thought that the exploration of this part of rural engineering was of prime necessity, because of the small number of scientific data on the subject. Everything was needed for the rational study of agricultural machines."

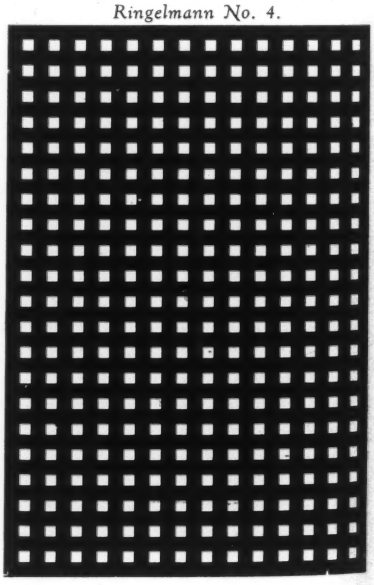


Ringelmann No. 2.

At the Bureau of Agriculture, Varenne Street, there was luckily a great scientific agriculturist, Tisserand, who for a long time dreamed of applying to the study of farm machinery an experimental method—the true scientific method.

All by himself he became an ingenious experimenter, capable of making his own instruments of investigation, to create an assembly of precision apparatus which

Ringelmann No. 4.



recorded the effects, the fruitless friction, the results, the spent work, the useless labor, the labor lost by the machines which the farmer could employ.

This experimenter, Tisserand, gave an account which Ringelmann could follow. He did not hesitate, though this agricultural engineer was so young, to entrust him with the creation, in 1888, of the Agricultural Machinery Experiment Station of the University of Agriculture. Ringelmann, who was named professor of mechanics in the preceding year, installed himself in extremely modest lodgings in Jenner Street, with hardly any credit at all. But he had faith in the work which he undertook, he had been endowed with a remarkable ingenuity which allowed him, with a little luck, to take the best part of the little bit he had to dispose of. He had, above all, a program which he wished to realize, and which he realized:

"To establish scientific principles for each set of machines, based on precise experiments, which would have a permanent value to be applied to machines proposed for the future."

At the base of all these researches he lacked measuring apparatus, and had only such as those of General Morin at his disposal. Ringelmann invented and had built various dynamometers and measuring apparatus which he left in the public domain, giving an example of disinteredness which characterized him in all his studies.

That these inventions should serve, that they should be useful, was his whole ambition. Today his apparatus is being used in experimental machinery stations created by foreigners on the French model. One can say nothing better about him than that he was able to do it!

In 1897 Ringelmann was named professor of rural engineering at the National Agricultural Institute. At 37, he became by his own merit the successor to the great creator of rural engineering, Hervé Mangon. Hervé Mangon had anticipated and desired this successor. Some years before, in a competition for the same chair, the wise master had said: "Ringelmann is most worthy, but he is too young. He shall succeed me later."

Ringelmann was a marvelous professor. He possessed a true talent as a draftsman and he loved to paint. We can testify to the fact that he could analyze machines, present in able sketches the different parts and make them understandable in their often extreme complexity.

He also had, through his personal studies, his experiences, and the missions with which he was charged in France and in numerous foreign countries — even the United States and Canada—by his historical labors, acquired an erudition without equal.

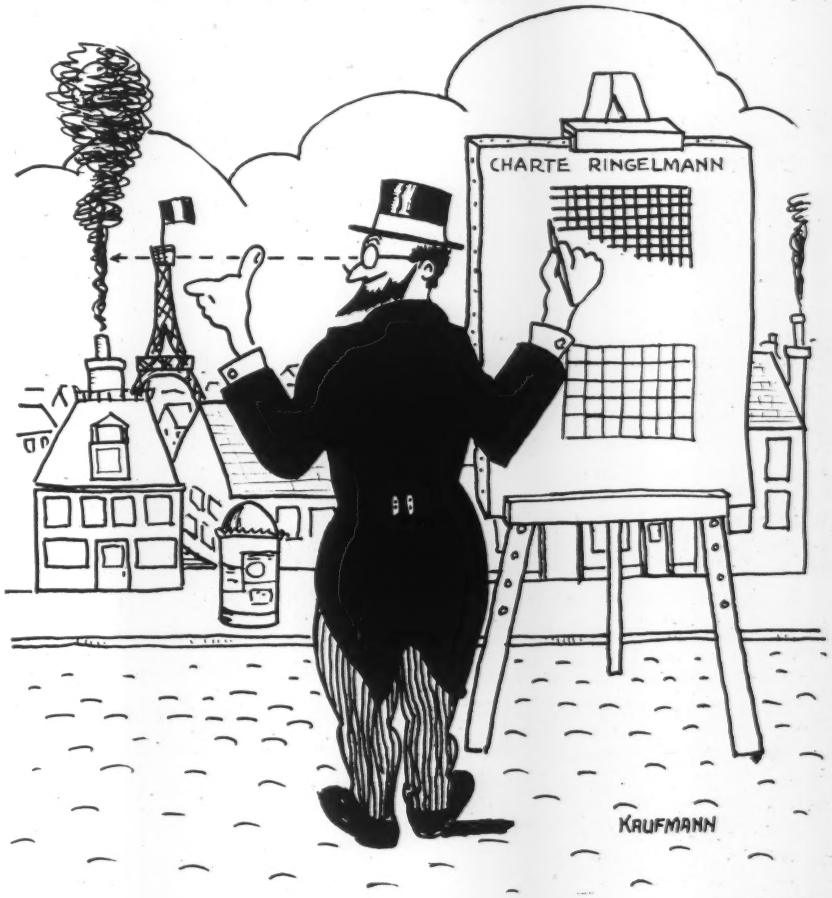
This learning, one felt each time that he spoke to treat on questions of rural engineering, took part in a discussion referring to agricultural machinery. But if we felt it, it was not to be displeasing, on the contrary, all the explanations of Ringelmann were clear, limpid, without pretention.

Ringelmann wrote much; there was hardly a question concerning rural engineering, farm construction, agricultural hydraulics, or farm machinery on which he had not published notes, memoirs, or reports in the Bulletin of the Ministry of Agriculture, in Agronomical Annals, in the Bulletin of the Society for the Encouragement of National Industry, in the Journal of Agricultural Practice, in which he wrote weekly since 1883.

His communications to the Academy of Sciences were numerous. Many had been also written for the Academy of Inscriptions and Belles Lettres. Ringelmann had, in effect, a sort of predilection for historical research, and among his works, one should at least recall his Essay on the History of Rural Engineering, whose first volume goes back to the prehistoric period.

Ringelmann belonged to the Academy of Agriculture since 1897, having been elected on March 31 of that year to the place which the associated national members left vacant, in the section of agricultural mechanics and irrigations, by the death of M. Champonois.

The inventor of the Ringelmann Chart died in 1931, at the age of 70, and of his numerous works and reports only one — *Charcoal, the National Fuel* — seemed to have some bearing on his studies that led up to formation of the chart. Otherwise the sources which your



Editor consulted were silent.

Rudolf Kudlich, senior mechanical engineer of the U. S. Bureau of Mines, throws some light on the Chart in Information Circular No. 6888:

"Wherever smoke abatement is discussed, the Ringelmann Smoke Chart sooner or later receives attention. It is strange that, though this chart is so commonly used and is of comparatively recent origin, its source and early history have been almost entirely forgotten. . . .

"The Ringelmann Smoke Chart, giving shades of gray by which the density of columns of smoke rising from stacks may be compared, was developed by a Professor Ringelmann of Paris . . . The chart was apparently introduced into the United States by William Kent in an article published in *Engineering News* of November 11, 1897, with a comment that he had learned of it in a private communication from a Bryan Donkin of London. It was said to have come into somewhat extensive use in Europe by that time. Kent proposed in 1899 that it be accepted as that standard measure of smoke density in the standard code for power plant testing that was being formulated by the American Society of Mechanical Engineers.

"The Ringelmann Chart was used by the engineers of the Technologic Branch of the United States Geological Survey (which later formed the nucleus of the present Bureau of Mines) in their studies of smokeless combustion beginning at St. Louis in 1904, and by 1910 had been recognized officially in the smoke ordinance for Boston passed by the Massachusetts Legislature. Since then many city ordinances have accepted it as the standard for measuring smoke density.

"In 1908 copies of the chart were prepared by the Technologic Branch of the U. S. Geological Survey for use by its fuel engineers and for public distribution. Upon its organization in 1910, the Bureau of Mines assumed this service together witth the other fuel-testing activities of the Technologic Branch."

There, readers, is what we have been able to pick up regarding the patron saint of the smoke abatement engineer. If anyone has any additional information, we will be greatly pleased to have it.

LABORATORY IN THE SKY

A condensation of Vol. 2, No. 2, April 1952 Issue of the New York University Engineering Research Review.

THE SIGNIFICANCE of balloons to science in the past has been small by comparison to the part they will play in the future. For now there is new and sharp emphasis on atmospheric research, due to its bearing on the development and operation of high-speed, high-altitude jet planes, and also to the intense current interest in cosmic radiation and nuclear research.

An American physician, Dr. John Jeffries, hung the first laboratory in the sky back in 1784, just two years after the Montgolfiers launched the first successful balloon. Dr. Jeffries' balloon was of taffeta, and his scientific equipment consisted of a barometer, a thermometer, an hygrometer—and several bottles for taking samples of air at different altitudes.

Typical of (the procession of intrepid scientists who risked their lives to explore the uncharted ocean of air) were J. A. Bixio and J. A. Barral, who made two ascents from the Paris observatory in 1850.

Their first ascent took place on a rough, windy day, in a balloon inflated with hydrogen gas, which had not been previously tested. When released, the balloon rose with startling rapidity, while the expanding gas thrust against the material of the balloon, making it bulge out between the network of ropes.

The suspension ropes holding the car in which the scientists traveled were so short that the car was soon pressed against the fully-inflated balloon. In attempting to straighten out the valve rope, the scientists tore a hole in the balloon, and were almost suffocated by the escaping gases.

But an even greater hazard was the velocity with which they began to fall toward the earth. To halt this, they jet-

Investigating the mysteries of the sky 100 years ago.

tisoned everything they considered expendable, including their coats and shirts. They finally reached the ground safely—half-clad, but still triumphantly clutching their precious instruments.

Sending Instruments Aloft

Not all manned balloon ascents had such a happy outcome. As the higher altitudes were reached, the cold and rarefied atmosphere added its perils to the other hazards of ballooning. Scientists lost consciousness at the high points of their flights, and some actually died for lack of air.

Since 1892 unmanned balloons carrying self-recording instruments have sampled the heavens for meteorologists. Much of the existing data on winds at high altitudes, on cosmic radiation, and on other phenomena have been collected in this fashion.

The laboratory of the sky is no longer subject to the uncertainties of chance. It is now possible to select the altitude at which a balloon will ride, and hold it there for long periods of time.

Controlling the Balloon

New York University's Engineering Research Division has played a key role in the development of the controls and instruments that have transformed the balloon into a practical, working laboratory.

It designed the constant-level balloon system that enables scientists to preselect the altitude at which they want their instruments held. It is even possible to hold the balloon system at one altitude until readings are taken, then make it ascend to another predetermined altitude for comparable readings.

To facilitate transmission of technical data collected during flights, the engineers conducted a program of developmental research on telemetering equipment, and designed an extremely light, battery-operated audiomodulated radio transmitter, with a two-watt output. This was further used in conjunction with developing practical aircraft tracking techniques for longer tracking time over larger areas.

Launching techniques were developed which have been widely adopted by organizations now using balloons in research. Not the least of the contributions of the NYU Engineering Research Division was the training of balloon research

Balloon used by New York University

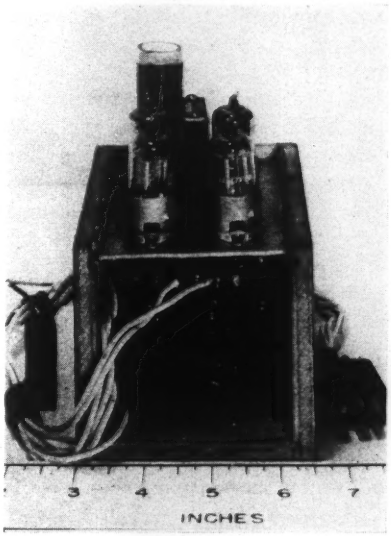
men. Leading balloon launching groups in the country include men who have received their training at New York University.

Catching the Airstreams

Until a few years ago, upper atmospheric research was of interest primarily to the "pure" scientists — men whose hunger for knowledge was almost equalled by their indifference to the uses to which it might be put.

But pure science has a way of becoming intensely practical with time; and today the phenomena of the upper atmosphere are of importance to a great many people concerned with the national defense and welfare.

Midget Measuring Instrument



The Air Force and the Navy are interested in forecasting the levels and duration of high altitude winds—the "jet streams" that move at greater velocities than the surrounding air.

Equipment used in jet planes must be able to stand up under conditions of temperature and humidity prevailing at altitudes hitherto unattainable by man. Balloons provide an inexpensive and reliable means of ascertaining what these conditions are, and what are their effects on materials and instruments.

Balloons are already employed in some of the most significant research on the nature and intensity of cosmic radiation. It is probable that balloons will be widely used in the future for radiation research, since they provide several advantages over any other existing method for carrying instruments to the altitudes where information on cosmic radiation can be obtained.

The next step toward a science of aeromedicine is the investigation of conditions in the area between 40,000 and 100,000 feet above the earth—a region about which relatively little is known from the medical standpoint.

The new balloons are well adapted for research at these altitudes. They can be employed to discover the effects of extremely low temperatures and pressures, solar and cosmic radiation, and other factors upon living organisms.

Study Air Pollution

Meteorological balloons have been used for many years to gather data useful in weather forecasting, but these balloons have usually operated in the lower levels of the atmosphere.

However, weather is also influenced by large-scale movements of the upper atmosphere; and high altitude constant level balloons will enable meteorologists to improve and refine their forecasting techniques.

Air pollution, too, can be investigated with the aid of balloons. In fact, small captive balloons with somewhat different characteristics from the large, high-altitude ones, are already used to sample air at intervals in studies of the behavior of smoke and gases emitted from stacks.

According to experts in the Air and Water Pollution Section of the Engineer-

ing Research Division, meteorological conditions strongly influence the dispersal of waste materials in the atmosphere. Full understanding of the atmospheric factors involved and the way they interact with other variables may lead to forecasting techniques that will make possible the alleviation of air pollution through control of stack emissions when weather conditions are unfavorable for dispersal.

Another kind of research in which balloons will help will be of noteworthy assistance to the farmer.

It is known that many kinds of plant diseases are airborne. Spores of wheat smut have already been found in the upper air. Plant pathologists look forward to the day when, through studies of bacteria carried by high altitude winds, the point of origin of plant epidemics can be located, and the diseases effectively and economically controlled at their source.

Transatlantic Flight

The new balloon systems have proved themselves in a number of flights to check meteorological theory and gather important new data. They have made cross-country flights in which their carefully plotted trajectories have furnished information on wind velocities and air trajectories.

Two balloons have successfully crossed the Atlantic Ocean, opening up the possibility that balloons may be used to obtain meteorological data over oceans, where only partial information is now available — and that little obtained at great expense.

TRAILS IN THE ATMOSPHERE

by PAUL L. MAGILL and ELMER ROBINSON
Stanford Research Institute, Stanford, California

WE HEAR a great deal these days about the new meteorological instruments that have been developed to tell us about the winds, the sky, and the atmosphere. We have explored the world's atmosphere farther away from the earth's surface than man has yet traveled. The new devices and the new concepts that have resulted from these modern scientific adventures are teaching us more every day about the vast ocean of air on whose floor we live, but there is still much that can be learned by using one of man's oldest meteorological techniques, namely watching what happens to smoke. Because smoke rises into the atmosphere, and because it flows with the wind, it provides a means by which the invisible currents of the atmosphere are made visible.

Observations of wind without some visual aid or special instrument would not readily reveal many of the interesting aspects of the atmosphere as it really exists. Our atmosphere is composed of many layers, and the motion of the air in one layer sometimes seems to have little bearing on the motion of the atmosphere in the adjacent layers. The flow of the air may be as smooth and untroubled as that of molasses syrup or it may resemble the turbulent action of wild rapids flowing through a canyon.

The manner in which smoke or other materials are mixed and dispersed by the action of the atmosphere gives important clues in any study of air pollution. Sometimes we see smoke issuing from a stack as a compact column and drifting off across the horizon almost unchanged in its ribbon-like pattern. We may ask ourselves why the smoke is not stirred and diluted on these occasions. Probably we should ask ourselves the question in reverse—why *is* the smoke mixed on those days when we see it become rapidly dissipated. Mixing of smoke in the air is not necessarily the normal situation, although it may be frequent. Energy is required to produce the mixing—energy from the heat of the sun and the earth's rotation. The direction of the winds, the amount of mixing whether vertical or horizontal, the height to which smoke rises, the manner in which it rises, and the direction it flows after it has risen, are all useful indicators of the state of the atmosphere. Some of these are illustrated in the accompanying photograph.

The photograph shows a most unusual atmospheric situation over a rather unusual city. It is a photograph of Long Beach, California, and the Palos Verdes Hills to the west. It was taken in midmorning on January 12, 1949 during a cold spell which set records for cold winter weather in southern California. There had been a thunderstorm the day before, followed by a snow storm which settled snow on the Palos Verdes hilltops. Lightning started an oil fire that burned two large refinery tanks. This fire produced the column of black smoke in the right background. The intense heat of this fire caused its smoke to rise much higher than the smoke from the surrounding sources. It entered an air stream which was flowing in a northerly direction. In the upper center of the photograph are three clearly defined smoke sources—quite different in nature—that are being blended into a single stream that flows southwest out toward the ocean in quite the opposite direction from the smoke from the oil fire. The white smoke is so dense that the three sources appear to blanket the entire area to the southwest under a pall of smoke.

The stratification of the atmosphere is shown not only by the different directions of the black and white smoke, but also by the low portion of the black smoke producing a streamer in the opposite direction from that of the main column. The atmosphere near the ground has relatively little vertical turbulence as shown by the smooth drift of the lower plumes.

Local meteorological observations give us more details concerning the conditions of the atmosphere. The Long Beach, California, Air Force Base sends balloons into the atmosphere carrying a radio transmitting weather instrument (a radiosonde) which automatically measures and transmits back to the ground the readings made during the ascent. On the day the photograph was taken the balloon ascended to well over 25,000 feet.

Radiosonde observations from the balloon showed that there was less temperature change between the earth's surface and about 8,000 feet above the surface than between the 8,000- and 16,000-foot levels. Had the air been appreciably warmer at the earth's surface than at the higher elevation, there would have been active vertical stirring of the air and spread of the smoke upward. If the air at the earth's surface had been much colder than that higher up, the cold air would then have rested firmly on the ground and there would have been even less stirring than is shown in the photograph. As the interpretation of the instrumental data and the smoke both revealed, the small difference in temperature throughout the first 8,000 feet permitted only very mild vertical stirring of the surface air.

At the Burbank, California, weather station, about 30 miles away from Long Beach, wind observations were made earlier this same morning at various heights. These showed greater wind speeds at the higher levels and wind in a different direction at 10,000 feet than at the ground. The difference in the directions of the smoke streams that were observed at the time of the fire show that this stratification must have extended over the area shown in the picture.

Greater wind speeds at the higher levels are indicated by the increased turbulence and stirring of the black smoke after it has penetrated into the more rapidly moving air stream.

The meteorological phases of air pollution studies almost always suffer from a paucity of accurate instrumental observations. However, careful interpretation of what we can see in the air can often be used as a replacement for fine instruments. Smoke and clouds as they are borne by the moving air leave a trail which can be observed, interpreted, and applied in the analysis of many air pollution problems.

Paul L. Magill is Engineering Coordinator of the Department of Chemistry and Technical Director of the Air Research Laboratories on the staff of Stanford Research Institute, Stanford, California.

He was born in Pocatello, Idaho. He attended Oregon State College for two years and was graduated with a Bachelor of Science degree from California Institute of Technology (Pasadena, California) in 1924.

For the two years following his graduation, Mr. Magill worked as a research chemist on the development of new products and the control and improvement of plant operations for the Pacific R and H Chemical Corporation at El Monte, California.

From 1926 to 1947, he was associated with E. I. duPont de Nemours and Company, Niagara Falls, New York. During his years with duPont, he acquired extensive knowledge and experience in the fields of electrochemistry, market and chemical research methods, special equipment design, gas handling, low-temperature production, gas phase catalysis, fluidization of solids, and continuous processing.

Mr. Magill has numerous patents in chemical processing.

He is married, has three children, and lives in Menlo Park, California.

Elmer Robinson is Associate Meteorologist in the Air Research Laboratory of the Stanford Research Institute, Stanford, California.

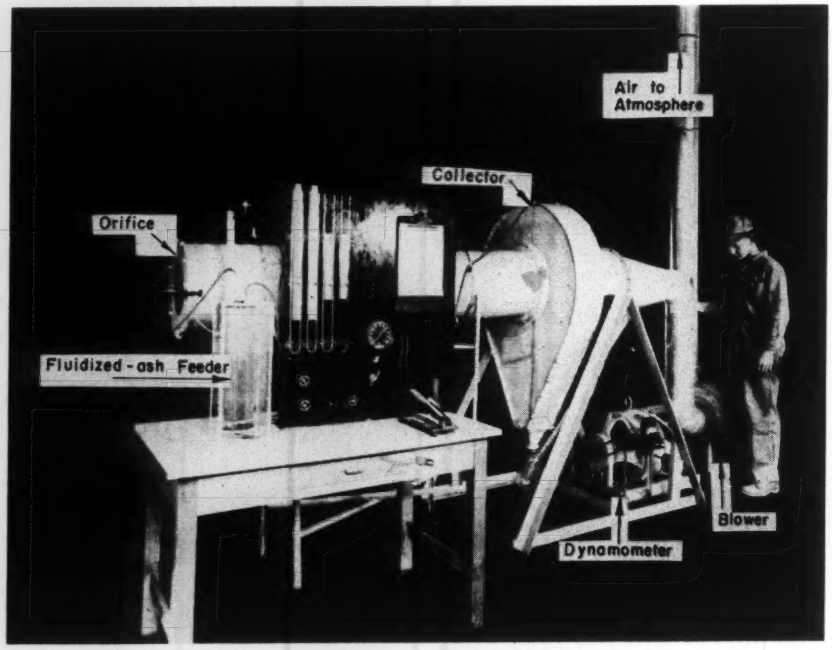
He was born in Los Angeles, California. During World War II he served in the Air Force as a Radar Observer and Navigator. He was graduated from the University of California at Los Angeles with a Bachelor of Arts degree in Meteorology in 1947 and received a Master of Arts degree in Meteorology in 1948.

Mr. Robinson has been with the Stanford Research Institute since 1948 and has been continuously associated with various phases of the research into air pollution which has been carried on in the Air Research Laboratory of the Institute. He is a Professional Member of the American Meteorological Society.

He lives in Los Altos, California, with his wife and two children.

Air Pollution Research at Battelle

by J. E. YOCUM and J. A. EIBLING, *Research Engineers,*
Fuels Division, Battelle Memorial Institute, Columbus, Ohio



Laboratory apparatus used in development of fly ash collectors.

THE ABATEMENT of smoke from the burning of fuel has long been the subject of study at Battelle. Within the past three years, however, this work has been expanded to cover the study of air pollution from any airborne effluent. Investigations in the field of air pollution have helped numerous industries find the most economical methods of reducing air contamination from their plants.

Smoke bomb tests were conducted for a large utility company to determine the minimum height to which the stacks of a plant would have to be extended in order to prevent downwashing of stack gases into a nearby community. A technique developed at Battelle was used for these studies.

Smoke bombs, held aloft by kite-balloons, were fired at various elevations above the plant stacks when the wind was blowing the stack gases into the nearby town. The smoke trace from various heights indicated the minimum stack height required.

Another use of kite-balloons which was developed at Battelle is a sampling tube or device which can be raised to a predetermined altitude above the ground to sample the air for both airborne dusts and gases. In this way samples near the outlet of stacks or a contaminant profile of the air can be obtained.

Directional dirt fall collectors, instruments recently developed at Battelle, are currently being used in several investigations. These devices collect dirt falling from each of eight compass quadrants according to wind direction and also collect separately the dirt which settles during the calm periods. These instruments are particularly useful in highly industrialized areas where they show the amount of dirt which falls when the wind is blowing from each octant.

Projects at Battelle in air pollution research are being carried on for a wide variety of industries. They include not only utility companies but also various chemical manufacturers and metallurgical industries. Research programs currently in progress range in size from those around individual plants to those covering a whole city and involving the study of a very complex mixture of air pollutants.

Battelle in the Power Field

Combustion work started at Battelle in 1929 with a project on the combustion of pulverized coal. In a large-scale laboratory furnace, basic data were obtained that have since been used by equipment manufacturers and coal users as a basis for design and performance of burners and furnaces.

Through the years, the Institute has worked on a variety of combustion projects ranging from small room heaters, developed in the laboratory, to research on large boilers in the field.

One of the leading industrial sponsors of research at Battelle in the field of combustion is Bituminous Coal Research, Inc., an organization of coal producers and railroads interested in improving and increasing the use of coal. Some of this work includes:

Fly Ash Emission. Information obtained from a survey of literature and of manufacturers indicated a need for inexpensive fly ash collectors suitable for small boiler plants. The survey also showed there were few reliable data published that correlated the amount and size of fly ash with such factors as coal size, firing rates, type of firing, and boiler configuration.

Battelle therefore called on industry to supply data in its files and, to supplement this, began fly ash emission tests on selected small boilers. Model studies of fly ash collectors were recently initiated in an effort to develop low-cost collectors that would meet the needs of small plants.

One of the leading research organizations is Battelle Memorial Institute, Columbus, O. Battelle conducts research for industry on a non-profit basis. Founded in 1929, Battelle has grown from an original staff of 30 until, at the present day, well over 1,900 persons are there engaged in scientific research.

During its first 20 years, the Institute served more than 2,500 sponsors. The amount of money invested in research at Battelle in 1933 was $80,000, and in 1952 will be an estimated $12,000,000.

The physical plant has been expanded several times since the end of the war, the latest addition being a million-dollar laboratory. The Institute has now more than 600,000 sq. ft. of laboratory and office space.

Richard B. Engdahl, who will represent Battelle Memorial Institute in the deliberations of our Association, taking the place of Dr. Hamnett P. Munger, has been with Battelle for more than 11 years. He is a native of Illinois, but moved east and took his degree of bachelor of science in mechanical engineering at Bucknell University. He later obtained his master's from the University of Illinois where he was a research assistant for several years, specializing in residential heating and cooling. Mr. Engdahl has been supervisor of fuels research at Battelle since 1947, and his investigations have included application of pulverized coal to metallurgical furnaces; overfire jets for smoke abatement; combustion and gas flow in coal- and oil-fired steam locomotives; application of pulverized coal to the gas turbine; distribution systems for pulverized coal and flow measurement; residential chimney performance; performance of steam jet ejectors; combustion on spreader stokers; development of low-pressure-loss dust collectors.

Smoke Abatement. One of the best tools for smoke reduction from stationary plants of all sizes is the overfire air jet. By providing turbulence and mixing of gases over the fuel bed, jets improve performance in many furnaces. While jets of various sorts have been used for over a hundred years, the first laboratory investigation for determining the optimum proportions of steam-air jets was conducted at Battelle. Later, additional information on overfire jets was published to enable each boiler-plant engineer to determine the jet installation suited for his equipment.

Research to provide a more complete understanding of the actions of overfire air jets has continued, and tests recently concluded are expected to show what effect jets have on cinder emission from a spreader-stoker-fired boiler.

Motive Power. The railroad locomotive has recently received a great deal of attention at Battelle. Most studies have been aimed at improving its efficiency and reducing the nuisance caused by smoke and cinder emission. Research here has included the effect on performance of type and size of coal, and of the "front-end" design. At present, the main effect is the collection and disposal of cinders.

A project was recently completed for one of the western railroads burning heavy fuel oil. Both model and full-scale road tests were used to improve the design of air-supply ports and burners.

The Locomotive Development Committee of Bituminous Coal Research, Inc., has under way the development of a pulverized-coal-fired gas turbine locomotive. As part of the project, Battelle recently completed work on the development of a combustion chamber for the locomotive.

As with many other projects, the work began with small-scale apparatus. In this case, the laboratory equipment was used to study the effect of pressure on combustion and to explore the general problems of combustor design and operation. The results demonstrated that pressure alone had no appreciable effect on combustion rate.

With this information as a basis, full-scale combustors for further research were constructed to operate at atmospheric pressure rather than higher pressure, at a substantial saving in cost of test equipment. At the conclusion of the project, combustion efficiencies above 90 per cent had been obtained with satisfactory air cooling of the combustor and without ash deposition.

Battelle has also conducted an investigation of the possibilities of extending railroad electrification. The project was sponsored by a group of major manufacturers, railroads, coal producers, and electric utilities.

Fundamental Research

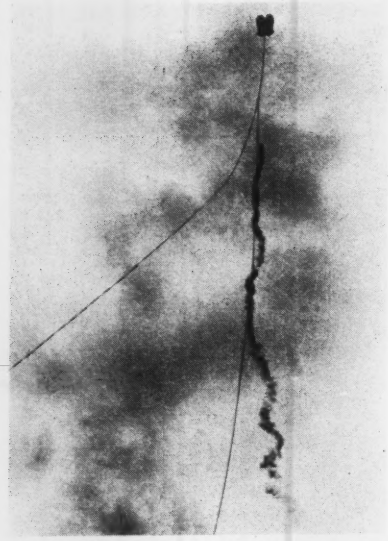
A large share of the research has been of a practical nature, directly applicable to industrial plants, but fundamental research has also received its rightful share of attention.

Low-temperature oxidation of hydrocarbons, the study of flame speeds, and acoustical oscillations in burners are a few examples of research of a fundamental nature. As aids in studying combustion reactions and the mixing of gases, Battelle designed and built its own mass spectrograph, a high-speed camera, and a schlieren apparatus.

Dr. Hamnett P. Munger, supervisor at Battelle Memorial Institute, has been a very good friend of the Air Pollution Control Association for many years, and served as unofficial secretary during the transitional period when the offices of the Secretariat were being moved from Chicago to Pittsburgh. He is leaving for Europe to represent Battelle there, and is regretfully severing his active connection with the Association. This versatile and engaging personality will be missed, but it is hoped that he will keep in touch with the Association from time to time, if his many new duties, plus his memberships in important technical and honorary societies, will let him.

Gasification of Coal

Battelle has been interested in the gasification of coal for a number of years and has worked in this field for several industrial organizations. One project, sponsored by the American Gas Association, has been active since 1945. The project is a fundamental study of the water-gas reaction, which is, in an overall sense, a reaction between steam and carbon to produce CO and H_2. The work of this project is directed toward determining the mechanism by which this reaction comes about, the rates of the individual reactions involved, and the influence of such variables as the temperature of the fuel bed. The problem has been approached by determining the conditions within the fuel bed of a small-scale water-gas generator.



Trace from a smoke grenade elevated by Kytoons.

Fuel Gas Economies

In 1949 Battelle completed for Bituminous Coal Research, Inc., a comprehensive survey of the commercial feasibility of making fuel gas from coal. The results of this work are described in a book, *Economics of Fuel Gas From Coal,* published by McGraw-Hill.

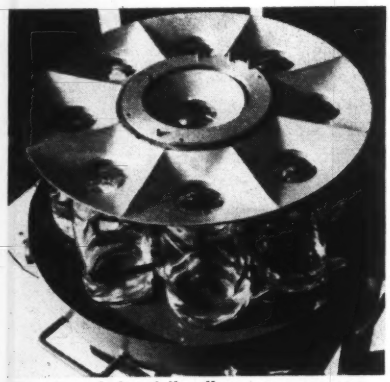
The authors, Dr. John F. Foster and Dr. Richard J. Lund, both of Battelle, conclude that the recent trends in the cost and the availability of the fluid fuels provides a new incentive for a program of research to develop an improved gas producer for use with bituminous coal.

With this objective in mind, Bituminous Coal Research, Inc., and Battelle appropriated funds for a cooperative program of research which is now supported by several other industrial groups.

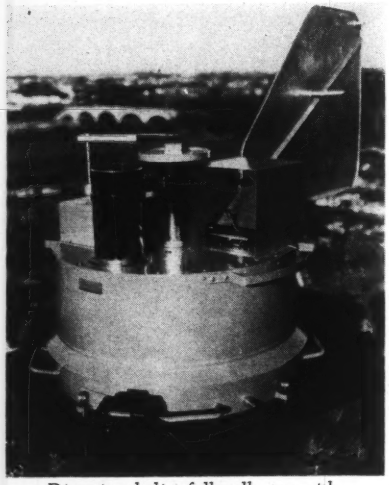
Residential Heating

So far, this discussion has touched only on typical projects in the power field. Activity in the field of residential heating may be of interest also. Broadly speaking, work in this latter field has consisted of research to improve home heating devices and of economic and engineering studies of home heating.

One of the particularly noteworthy projects was the development of a method for burning bituminous coals in nonmechanical, hand-fired heaters or furnaces with substantially smokeless operation. The research was sponsored by an agency of the coal industry, and a group of stove manufacturers.



Directional dirt fall collector in operation.



Directional dirt fall collector with cover removed.

Work is still going on to help stove manufacturers to get into production on units built on the principles and design features evolved during the development.

The heat pump, which is one of the newest methods of heating, has been investigated as to its feasibility for space heating, for heating service water, for drying, and for other uses. The heat pump shows promise of becoming an important device for many heating applications. On the other extreme, experimental work on the lowly fireplace increased its overall efficiency.

The residential stoker is another domestic heating device that has been given much attention. The principal objectives have been the adaptation of stokers to a wider range of bituminous coals, improvement in performance, great automaticity, and the establishment of the proper types of coals for stokers already available.

RECENT AND READABLE

Air Pollution

Report to the New Jersey Legislature on air pollution in New Jersey and recommendations for its abatement. Library of Congress TD887.N4 1952 628.52 52-62529

Construction of Automatic Air Sampling Apparatus, by H. G. Bourne, Jr. *Heating & Ventilating,* January, 1952.

Atmospheric Sanitation in Los Angeles County, by F. H. Viets, *Heating & Ventilating,* February, 1952.

Relation of Spreader Stokers to Air Pollution. *Combustion,* July, 1952.

Atmospheric Pollution Problem in Canada. *Chemistry in Canada,* August, 1952.

Smoke Abatement

Glass Bags Clean California Air, by P. Stechert and H. B. Menardi. *Iron Age,* January, 1952.

Direct Steaming Solves Smoke Problem at Freight Terminal, by J. M. Dyke. *Power,* February, 1952.

"Shock" Treatment Solves Smoke Problem. *Food Engineering,* February, 1952.

Is Smoke Your Problem? Here's What to do About It. By R. B. Lemkuhl. *National Engineer,* March, 1952.

Power Plant Performance Data at Bernheim Distilling Company, Louisville. By R. Cooper. *Southern Power & Industry,* April, 1952.

Manufacturer's Viewpoint on Preventing Smoke and Air Pollution by Coal-fired Boiler Plants. By E. C. Webb. Paper presented before ASME meeting. June, 1952.

Preventing Air Pollution From Coal-fired Steam Generators. By C. E. Miller. Paper presented before ASME Meeting June, 1952.

Proper Design — Installation Application of Coal Burning Equipment for Boilers (25 - 500 HP.) To Prevent Smoke and Air Pollution. By H. C. Ballman. Paper presented before meeting of ASME June, 1952.

Design, Installation, Application of Fuel Burning Equipment for 25 - 500 h. p. Range, to Prevent Air Pollution

by C. W. GRUBER, *Chief Smoke Inspector*
Bureau of Smoke Inspection
City of Cincinnati
Cincinnati, Ohio

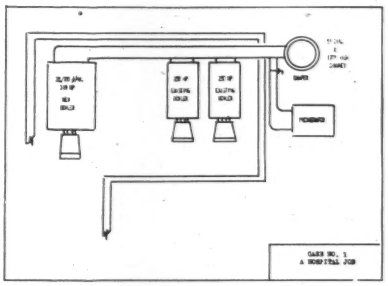
Contributed by the Fuels Division for presentation at the Semi-Annual Meeting, Cincinnati, Ohio—June 15-19, 1952, of The American Society of Mechanical Engineers.

PLACE ONE EGG, 1 cup flour, ½ cup sugar, 1 ts. baking powder, ¼ ts. salt, ½ cup milk, 3 ts. butter, ¼ ts. vanilla in a bowl and mix 4 minutes. Bake in oven at 350° for 20 minutes, and out comes a golden, delicious, 1 egg cake. That is, if you have been careful in following directions to the "T". If one small ingredient such as the baking powder has been left out, the cake will fall flat.

What has baking a cake to do with the subject of "Design - Installation - Application Fuel Burning Equipment for 25 - 500 H. P. Range to Prevent Air Pollution"? It simply illustrates an important point: In baking a cake, or putting a boiler plant together, *the details are important*. Forget one detail and the whole job may fall flat.

This paper will deal primarily with the small plant in the 25 - 500 HP range. This range should probably be referred to as the *smaller plants* as compared with the power plant of capacities less than 250,000# steam/hr. and identified as a small power plant by F. M. Swengel in a paper before the ASME in Cincinnati in 1950. It is in this smaller range we often find boiler plants being assembled by plant management without the assistance of the professional design engineer. It is not implied here that staff engineers are incapable of assembling a working boiler plant. That is not the case. However, the smaller the plant, the more varied are the duties of the responsible plant engineer, and the time required to properly fit one piece of equipment to another, and the whole boiler plant to the service demanded is frequently lacking, so that important details are often missed.

Many papers have been written on the positive approach, that is, the step-by-step selection of equipment to fit the job. Many recipes for a successful job can be found already in print. This paper, at the risk of having it tabbed as psychologically wrong, will discuss actual cases in which some details were overlooked, and thereby left a trail of smoke which brought in the City Smoke Inspector to haunt the plant manager until the job was finally ironed out.

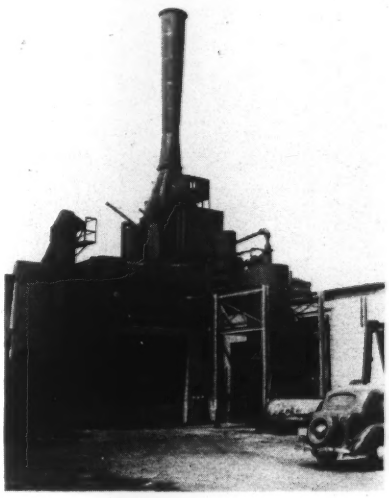


Case No. 1. General arrangement of boiler room.

Let's get down to cases:

Case No. 1. A Hospital Job. A 319 HP (22,000 lbs. per hour output), 3 drum Stirling boiler was installed in an existing boiler room. The new boiler was added to two existing 250 HP water tube boilers, to be used alternately with the battery of existing boilers. No structural changes to the building were required. A 5' diam. by 170' high chimney was available, and was considered adequate.

Case No. 2. Exterior view of power house. Coal elevator on left. Dust collector and ID fan on roof. Ash tank and dust separator on ash conveyor system at right.



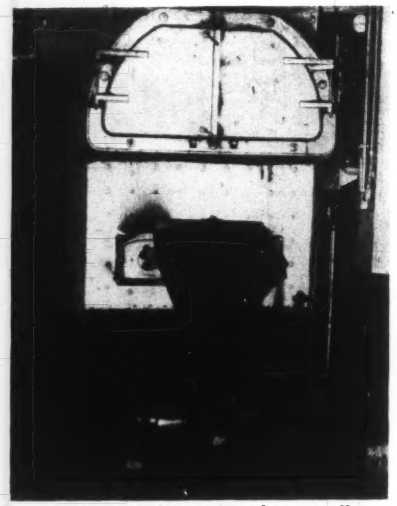
When the new boiler was put on the line, it was found that the boiler design capacity could not be reached without rodding the stoker fire. The results of the rodding were very dense smoke, which brought the smoke inspector on the job. First the coal was blamed for the trouble. The coal was then "hand-picked" but no improvement was noted. Then the stoker man and boiler man were called on the job. The baffling of the boiler was checked out O.K. The stoker forced draft fan was then speeded up. The firebox temperatures became excessive. Further investigation revealed that there was 0.3" draft loss between the base of the stack and the new boiler. It was found that in addition to the two existing boilers an incinerator was connected to the breeching. A tight incinerator damper was installed and the dampers of the two "dead" boilers were refitted. The draft on the new boiler became ample, but the smoke continued. The forced draft fan was again increased, and a separate motor drive installed. After this last change was made, the smoke was eliminated, the load easily carried, and excessive temperatures in the furnace were eliminated. The job was then O.K.'d. For the Cincinnati Smoke Inspection Bureau, the case was opened on June 11, 1948, and was considered closed more than a year and a half later (January 16, 1950), after more than 30 trips to the plant by the BSI staff, answering dozens of citizens' complaints of smoke, much "passing of the ball" between

the coal supplier, the stoker contractors, the operating crew and the designing engineer. Since January 1950, there have been no smoke violations charged against this plant. The lessons to be learned from this job are that "dead" equipment can materially affect stack draft unless it is thoroughly sealed by tight dampers, and the lack of flexibility of stoker control and undersized forced draft fan with no over-fire air to handle unusual situations can cause serious operating difficulties resulting in dense smoke.

Case No. 2. The Case of the Elusive Fly Ash. A 300 HP 3 drum water tube boiler was installed in 1948 in a corrugated paper mill, as an alternate boiler for an oil-fired unit which was slightly under sized. The new boiler was fired by a pneumatic spreader stoker, having a maximum burning rate of 1600 lbs. of coal per hour. The boiler installation was very complete, incorporating coal handling, automatic combustion control, induced draft fan with high efficiency fly ash collector, as well as over-fire air unit. This job appeared to have "class", except for one thing. There was no ash handling system.

When the job started in June of 1948, the ash handling was by the "heave-ho" method. The collector hopper on the fly ash separator was drained daily into 55 gallon steel drums, and stored for removal by truck. Fifteen such drums were filled with fly ash every day. The drums were then man-handled on to the truck with dust flying everywhere. In order to save excessive labor, and to eliminate dust from blowing back into their own plant, a steam jet conveyor system was designed, blowing the ash into an outdoor tank. The system was installed during the '48 - '49 winter, and on the first nice spring day, the parade of fly ash complaints from the neighbors commenced.

Analyzing the conveyor and tank system, it was found that a beautiful fly ash classifier was built. The coarse material fell into the tank, and the fine, light, troublesome ash went out the stack and over the



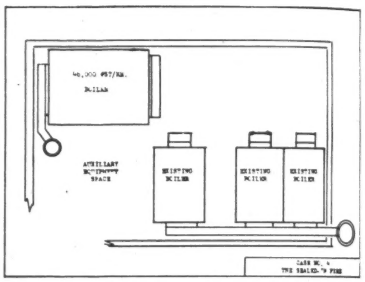
Case No. 3. Boiler and stoker installation showing extend setting, providing adequate combustion volume and convenient cleaning.

neighborhood. The breeching loaded up to the point where the fly ash collector became ineffective.

So after many complaints, another change was made. This time, through the insistence of the BSI, a properly designed washer was installed on the exhaust from the cinder tank, the return from the conveyor system was removed from the stack. A water spray was installed at the tank unloading gate. This system worked fine until winter again set in. On the first zero day, the conveyor line froze up and stopped the entire system. However, after a minor correction was made permitting the line to properly drain, the system could be operated even in sub-zero weather. The entire system is now operating very well, and all complaints from the neighbors have ceased.

The lesson to be learned from this job is very important. No solid fuel burning job is complete until provisions are made for removing the ash from the premises. There is really no benefit in separating ash from flue gases if in the handling of the ash, it is again blown out over the neighborhood a few hours later.

Case No. 3. The Case of the Black Center. For the past several years the Cincinnati Board of Education has had a modernization program. Each year the heating plants in four or five schools are equipped with new boilers and stokers. The units are fairly standard, utilizing 100HP boilers, with 600 lbs./hr. stokers. In 1949 a different manufacturer's stoker equipment was selected on the basis of their low bid. When the units were fired up in the fall, smoke trouble immediately developed. As usually happens when smoke occurs, other serious difficulties show up. In this case the stokers would not carry the load. Inspection



Case No. 4. General arrangement of boiler room.

revealed a black center in the fire—in other words, the fire was burning on the dump grates, with no fire whatsoever in the center of the furnace, and the coal piling up in the center. Although it was obvious that improper air distribution due to a wrong tuyere design was the cause of the trouble, this was not admitted by the stoker man until he and the coal man had gone through the usual "buck passing." The tuyeres were altered at the suggestion of the BSI to get air penetration to the center of the fire. The smoke cleared up and the load was easily carried. No trouble has developed from these units since.

Several months later, this same stoker manufacturer put a set of fuyeres similar to the school jobs on the small commercial stoker of a

Case No. 3. Original tuyere showing excess air opening. Openings indicated by arrow were sealed off.

different manufacturer. The same smoke trouble and the same conditions developed on this job which had previously operated successfully for a number of years. In spite of the recent difficulty on the 7 school-house stokers, the coal was again blamed. After several long distance telephone calls, and two hours of discussion on the job, the air distribution was altered and the operation difficulties disappeared.

The lesson is obvious. Proper tuyere design for good air distribution through the fuel bed is essential.

Case No. 4. The Case of the Sealed-in Fire. A 46,000# steam/hr. water tube boiler was installed in a packing plant to meet the growing steam load. An addition to the existing boiler plant had to be built. Because of limited property available, the boiler room conditions were very crowded. In fact, the right hand wall of the boiler was placed against the building wall. The boiler was equipped with a multiple retort, underfeed stoker, complete with automatic combustion controls. The boiler was equipped with an induced draft fan and its own stack.

Not long after the unit was placed on the line, smoke trouble developed. On the first inspection, it was impossible to determine what was going on inside the boiler because adequate observation doors were not placed in the boiler setting. No overfire air system for smoke control was originally installed. However, steam air jets were added at a later date.

After a number of minor skirmishes between the Smoke Bureau and this plant, a full scale battle developed and the plant is now in the process of determining how the boilers can be fitted with the proper observation doors so that the operators can properly adjust the firing equipment to meet changing load and fuel conditions.

The lesson to be learned in this case is that instruments cannot substitute for the observation of the fire itself. The condition of the fire is the key to good operation, and facilities must be provided to observe the fire.

We could go on with citing one case after another where some detail of the whole job was overlooked; seemingly unimportant, but causing a great deal of expense to correct, or aggravation to live with throughout the life of the plant.

Establishment of Responsibility. Perhaps the most important principle to establish in the development of a smaller plant is the delineation of responsibilities between the various contractors. This applies particularly in areas where Municipal Codes establish certain requirements which could be placed in one of several contracts.

For example—Is the boiler man or the stoker man responsible for the furnace design? You might say that the stoker man must make his installation comply with combustion requirements of the Code. But in many cases the boiler is bought before the stoker is selected, and then the stoker man comes to the smoke regulation engineer and begs for relief because the firebox is too narrow, or too low, or the doors are to high for proper cleaning. A little coordination and forethought in selection of the boiler could provide an ideal stoker setting where, all too often, the job must be compromised.

In Cincinnati, where the Air Pollution Control Program includes the prior approval of plans and specifications for fuel-burning equipment and subsequent inspection, it is estimated that in the 25 to 500 HP range, more than 75% of the applications for permits filed with the BSI lack sufficient information to properly check out a job. The information required is set down on a printed form. Every effort has been made to boil down the information asked for to the bare essentials, which must be known to properly design an installation in the first place.

In new construction projects where plans and specifications are filed with the building plans, data is available in most cases, but in the replacement jobs, applications must be returned with regularity, rechecked for more information, or the City Engineer must call the applicant by phone in order to push the work along. Why should this be?

Projecting this situation into areas where there are no installation codes, it is hard to believe that jobs are "engineered" better because there is no control. The only conclusion that can be drawn is that where no control is exercised, details such as chimney size, loads, com-

OUT OUR WAY
BY J. R. WILLIAMS
NOTICE HOW TH' SHOP FUMES GET A LITTLE MORE TANGY IN TH' AUTUMN, AN' TH' CEMENT A LITTLE CHILLIER ON YOUR FEET?
WHY, I COULD TELL TH' SEASONS JIST WITH MY CHEEK AGINST THIS STEEL POST!
NO KIDDIN', OUR SENSE OF CONCRETE AN' STEEL WILL BE SO FAR DEVELOPED WE'LL BE SEEIN' TH' BROWNS OF AUTUMN AN' TH' GREENS OF SPRING IN 'EM!
10-10
J.R.WILLIAMS
T. M. REG. U. S. PAT. OFF.
THE MODERN WOODSMEN
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bustion in volume, go unchecked, resulting in a number of jobs which fail to meet the standards of good performance.

For a number of years, the Cincinnati BSI has made a check on the causes of smoke violations. Six years ago (1946), 48% of observed smoke violations were attributed to such things as misapplication of combustion equipment, obsolete equipment, poorly maintained equipment, that is, causes other than improper operation. In 1949, the first Annual Inspection of coal and oil-burning commercial and industrial plants was made as required by the Anti-Smoke Ordinance. Out of a total of 4500 plants inspected, more than 1000 had major defects. 100 plants had *no* means of controlling stack draft, 358 plants had broken, warped or *no* cleanout doors on breechings and chimneys, 186 plants which were required by the Ordinance to have smoke indicators, had no means of observing their chimneys, or no smoke signaling equipment; 256 plants had no settling chamber in the base of the chimney; 198 plants were "choked up" with soot and fly ash.

Concentrated effort has reduced visible smoke violations and greatly improved plant conditions. Last year (1951), 26% of observed smoke violations were laid to causes other than bad operation, and on annual inspection, only 196 plants were turned down for major defects.

Another paper presented on the panel is devoted mainly to the solution of the problems discussed herein. However, in order to get straight with the rules, and shift from the negative to the positive side, several brief statements as to what can be done to improve the situation are made:

(1) Closer liaison between boiler and stoker manufacturer should be maintained in order to get boilers designed and built to better accommodate underfeed stokers. This is particularly applicable in the C. I. boiler field. Smaller boilers are still made too narrow for proper clinker storage space, and doors are set too high. Some manufacturers have made special stoker-fired boilers, but they are seldom found on the job.

(2) A clear understanding and agreement on the application of overfire air jets to stoker installations should be arrived at. Some hold that such installations should go in on all jobs above a certain size. Some say that only after trouble develops should the over-fire air jets be installed. The proper design, the selection of the volume of air over the fire, and the proper control should all be definitely agreed upon. B.C.R.'s new manual 500-300, "Application of Overfire Jets to Prevent Smoke from Stationary Plants," is a step in the right direction, but more definite values must be agreed upon.

(3) Stoker designs should be proven by test and required to meet performance standards. There should be a central testing organization, or a certifying organization to forestall such difficulties as occurred in the City School jobs.

(4) Design, installation service responsibility in the size range of plants being discussed is a real problem. Manufacturers of equipment must retain more control over the application and installation of their equipment to see that it is properly applied. Strong, uniform City codes will benefit, but only where such installation codes exist.

(5) A fuel engineering service would be of material benefit. Packaged plans and specifications which reflect the best engineering knowledge available on the application of fuel-burning equipment, supplemented by proven engineering data on chimney requirements, combustion controls, smoke and fly ash eliminating devices, draft controls, etc., should be available to all persons concerned with putting together a fuel burning plant in the range of 25 to 500 HP.

In conclusion, it is hoped that this paper will focus attention on the need for expending real effort to understanding the importance of thinking of every job as a whole. The boiler, the firing unit, the controls, the chimney, the fuel, the operators, the smoke signaling equipment, the coal and ash handling equipment, and the neighborhood protective equipment are all vital parts.

The large plant is not considered complete until each segment is carefully engineered to fit into the whole plant. But in this range of smaller plants, it is too often a pieced-out job. A way must be found to wrap up various packages so they can be brought off the shelf with a great deal more certainty that the "baking powder" has been stirred in and that the plant will raise to serve its owner efficiently over a long life, and without the smoke inspector coming back to haunt him.

BROOKLYN POLY TO GIVE COURSES IN AIR PURIFICATION

THE POLYTECHNIC INSTITUTE of Brooklyn is planning a program of courses in air pollution this fall as a service to the civic and industrial groups in the New York City area.

The program is divided into the following phases: smoke control, chemical fume control, odor control, etc. Each of the phases is further subdivided into two sections: one for graduate engineers, one for plant operators.

The course in smoke control will include the theory of combustion with reference to the formation of smoke, theory of application of control devices, and basic legal aspects of smoke control.

Clifford A. Wojan, assistant professor of mechanical engineering at the Polytechnic Institute of Brooklyn, will head the air pollution courses to be given at the school. He is an alumnus of Poly with a degree in mechanical engineering, and is also a professional engineer and a licensed marine engineer. He serves as a consultant in heat power problems and is a member of several technical and honorary engineering societies.

The Role of the City in Air Pollution

by JOHN L. HODGES, *Chief, Division of Air Pollution Control*
City of Philadelphia
Presented at Pennsylvania Department of Health Annual Health Conference at Pennsylvania State College
August 26, 1952

AIR CONTAMINANTS carried by the wind have been known to transgress city, county, state and national boundaries. Yet, air pollution control is generally conceded to be best administered locally. To control air pollution, the source should be determined so that abatement methods can be studied and put into effect to bring the emission below a nuisance value. This alone is sometimes a major problem. Air pollution control officials have found by experience that the public is very much interested in a nuisance and want it stopped. They are not as interested in the cause or source. The cause or source is very imporant to the air pollution control official.

The role of the city in air pollution control is to accomplish a reduction of atmospheric pollution by reasonable and practical means. In this way, continued and most significant progress is made. As progress is made, there will be less and less air pollution to transgress the city boundaries. To accomplish this the following tools are important:

1. A sensible, practical law that can be administered and enforced effectively.
2. A well staffed department with capable and trained personnel, free of and above political influence.

A sensible, practical law takes into consideration such factors as the size of the city, its industrial population and financial resources. A small city with few industrial plants would not need as complicated an ordinance or law or as large a department as a large city with many industrial pollution problems. As a rule, the simplest law that is adequate is the best. A very stiff ordinance that cannot be enforced without hardship is meaningless and creates criticism of the enforcement authority by citizens.

The head of a smoke abatement or air pollution control division should be a qualified professional engineer, mechanical or chemical, with combustion experience. Experience in industrial hygiene is also a valuable asset. Experienced operating engineers make good smoke abatement inspectors and they can be trained in other phases of the work.

An inspector must be a man of even temper, able to handle the public, an irate tax payer, or go into a fire room and show a fireman with a hand-fired plant how to reduce smoke emissions, and then go to the front office and talk intelligently and persuasively to the manager, superintendent or president. A large amount of on-the-job training is necessary to bring a man to the point where he is an air pollution inspector.

Most cities have difficulty in recruiting for a new smoke abatement or air pollution control department because competition with industry is keen and industry is willing to pay more for the calibre of man desired. Most city departments operate on a very limited appropriation because of far too small a concept of the problems involved by municipal officials and the public, when it was decided to institute such a department. Usually a few men are provided to staff an organization with duties comparable to keeping the streets clean.

Smoke abatement is usually the major part of any new air pollution control unit, and of course, the main function of a smoke abatement department.

Mr. Hodges

As the visible smoke diminishes, the dust problem becomes more noticeable and prominent, and along with this come fume and odor problems.

Dust Control

I do not believe there are 200 men in the entire United States or Canada that can take a flue dust measurement and arrive at the correct lbs. of dust per thousand lbs. of flue gas, or the grains per cubic foot at 12% CO_2 or 500°F within a plus or minus 10%. And —if the ordinance says this measurement must be made in accordance with the "test code for dust separating apparatus of the American Society of Mechanical Engineers"—you have two strikes against you before you start to take a dust loading sample.

In the first place you have to get into the plant, get the cooperation so that there is a suitable platform and two or three holes to obtain a sample in order to get a reading.

STATISTICAL TABULATION

A veritable gold mine of information for air pollution control officials is the copyrighted *Statistical Tabulation* just issued by the Secretariat.

It was compiled from information furnished to the Association during the past year by those bureaus spending more than $5,000 a year. It contains such items as number of inspectors per bureau, total annual budget, percent recovered by fees, cost per capita of administering an air pollution control department, and total coal tonnage in the district.

Of great value is the tabulation on the salient points of some smoke ordinances, including permissible limits of smoke emission, fly ash and exceptions to the general rules concerning it, whether or not the bureaus have the power to seal off offending boilers, and general remarks pertaining to individual cases.

The tabulation sells for $1.50 a copy, members obtaining one copy on request, additional copies to sell for $1.00 to members only. Some quantity discounts will be allowed. Send for your copy—or copies—by writing to the Secretariat!

In the second place the Company is usually alerted so as not to be emitting what it usually does at the time of taking a sample. If the average consulting engineer takes a sample and arrives at a dust loading reading, someone that knows how to do it correctly from the city department should be on the job also to check the method of taking the sample, and evaluating the results. It is very difficult to administer such an ordinance across the Board for all plants, large and small. Control equipment is expensive, so for the small plant might cause financial hardship. Of course it is all right to have such a clause in the Ordinance for the control of dust emissions from large plants.

Many variables are involved on a flue dust control problem, such as height of stack, size of particles emitted, velocity and temperature at which emitted, velocity and direction of the wind and amount of moisture in the air at time of emission. Those who wish to purchase equipment for flue dust control want to be sure it will work satisfactorily and bring emissions in compliance with the ordinance before such expenditure is approved.

It may be difficult to pin point the source, when a dust complaint is received.

Fumes

Air pollution from an industrial process other than the process of the combustion of fuel, is caused by emissions that are a functional part of the plant operation or manufacturing process. Better design and careful operation rarely can prevent these emissions, like they do in smoke abatement. When dust, fumes and vapors are an integral part of the operation, mechanical equipment must be designed to remove these emissions.

This is largely a new and untried field of control. Much pioneering work must be done by industry requiring new engineering design and research. Such control is investment in community good will by industry.

With noxious fumes caused by toxic gases there are no existing standards except the maximum allowable concentrations of industrial atmospheric contaminants published by the American Industrial Hygiene Association. These standards are for a well man working in a plant eight hours a day, six days a week. They cannot be applied to the general public where would be found people who might be particularly allergic on account of age or some disease peculiar to themselves, such as asthma or heart trouble. Lower and correct standards need to be determined for the public and the engineers and doctors will have to work together on such a determination. This will involve necessary research difficult to evaluate because toxicity affects individuals differently.

Odors

Odors cannot be measured. There is no positive way of determining when an objectionable odor becomes injurious to public health or how many people must be annoyed in order for the nuisance to be a public nuisance. A bad odor is air pollution just the same as black smoke, according to the average citizen.

I do not know of any air pollution control ordinance that prohibits industrial odors as such. How to do these in such an ordinance without doing an injustice to industry is a problem that some of the best legal talent have spent much thought and time on without tangible results.

The basic methods of odor control are (1) modification of process to prevent formation, (2) treatment of the odor-carrying air by a catalytic agent, (3) scrubbing the air in a suitable absorption unit, (4) absorption of the substance on activated carbon, (5) passage of the air containing the odor through a suitable fumes burner and (6) delivery of the gases to a tall stack to effect adequate dilution. Any method used to control an odor as economically as possible must be based and tried upon a sound engineering analysis of the individual problem.

The air pollution control department probably will not have authority by ordinance to require any of the above measures. Consequently odor complaints present problems difficult for the air pollution control officials to properly administer. Most odor complaints fall in the category of a private nuisance and may not come under the air pollution control ordinance.

Role of the City Department

When an air pollution control department encompasses elements of air pollution beyond smoke abatement such as dust and fumes, pioneering is being undertaken. The price of pioneering is that the work and any progress will not be appreciated, nor understood. The relative few in the community that division personnel come in direct contact with, engineers and management, will know the department is trying to accomplish air pollution control in new and untried fields. They will be convinced that the department has a job to do and a responsibility to the community in doing it. However, the public will not understand or believe much is being accomplished.

One of the most difficult tasks in air pollution control work is to get constructive, correct and factual publicity in the newspapers and to the public, so that the problems are more appreciated. Educating the public is difficult, probably impossible. Air pollution control is not a spectacular business. It is a job that requires hard work, daily plugging and accomplishing the most possible, with the available personnel, to reduce air pollution in each plant as the problems arise. It is the earnest desire of most industrial plants to be a good neighbor. If a nuisance is being created, they will usually cooperate to endeavor to reduce any emissions below a nuisance value if it can be done economically. Industry has the plants and the problems and some industries—steel, chemical and utilities for example,—are carrying the ball in the endeavor to control air pollution by spending millions of dollars in the United States and Canada for control equipment and research which no municipality can afford.

The air pollution control department of a city cannot act in the capacity of consulting engineers, yet it can assist industry and recommend ways and means to reduce air pollution. It cannot and must not sell equipment. However, at times, personnel of the department will be accused of doing these things and more—that either the department head or one or more of the staff is being paid to overlook violation of the ordinance.

Air pollution problems will challenge your best efforts and many times your best will not be enough; but progress is being made and more will be made.

There is a vast void between the physicist and the ordinary fellow who is the head or on the staff of a smoke abatement or air pollution control department. This void will gradually be filled as we learn more about how to solve air pollution control problems. We do not know enough yet, but learn more day by day. That is what makes the work interesting and challenging.

No city has a monopoly on air pollution control, for there is much to do and too few to do the job. One of the outstanding features of air pollution control is that the air pollution control officials throughout the United States and Canada realize that they do not know all the answers and whether they are state, county or city officials, it has been my experience that they are ready and willing to help the other fellow with a problem if possible. The relations between the Air Pollution Control Division of the Department of Industrial Hygiene of the Commonwealth of Pennsylvania and the Division of Air Pollution Control in Philadelphia have been very cordial and mutually helpful and beneficial. It is a privilege and a duty of the head of a department in a large city to answer any requests for advice or assistance from another location, particularly if one comes from a smaller place where air pollution control problems may not be as varied.

A city air pollution control department must be divorced from political influence in order to function effectively. If the air pollution control work is kept on a high engineering level, it is very helpful in keeping politics out. To do this, the department personnel must know their business, so that they can approach problems with confidence. Because of the difficulty of putting air pollution control over with the public, the department should have the confidence of the leaders of the incumbent political administration so that they will help public good will by giving the department a boost occasionally on television and radio programs and in talks at meetings. The department must earn the confidence of industry and thereby gain their cooperation. In the final analyses, industry themselves must spend the money and reduce air pollution for theirs are the plants that make the pollution and theirs is the know-how to best experiment on how to control it, practically and as economically as possible.

The department cannot be successful without the cooperation of industry. The confidence and cooperation of industry are the most important factors, in my opinion, for a smoke abatement or air pollution control department to show steady progress on a control of air pollution has been the inability to visualize the magnitude of the job. Abatement of air pollution is a major community problem. In the past, in so many places, the problem has been thought of in too small terms. Some kind of law was passed and personnel appointed to the work, who did not have the qualifications to meet the responsibility given them.

When all concerned realize that keeping the air clean is a project of similar magnitude to keeping our streets clean, providing pure drinking water and guarding the moral atmosphere of the city, there will be successful air pollution control.

The technical side of the problem is quite involved. Plus this, you have the human element to deal with, which requires tact, patience and perseverance. Apathy of public officials, unwillingness of the public to foot the bill and sometimes opposition by industry combine to make the problem of cleaning the air a difficult one. Only a small number of installations for smoke and fumes control pay their way for the industries involved.

When a community organizes for reduction of air pollution it is important to secure the right kind of individual to head the work. Primarily, he should be a good combustion engineer. He must also be an administrator, a diplomat, a public speaker and have initiative, tact and versatility. He should have practical experience in burning fuel. He must have persistence and ability to get things done.

The public often expects results much more quickly than it is possible to accomplish them. A long-range program is the only kind which will be successful. Never overlook the fact that air pollution control is a major community problem. The nature of the work is such that time is required to accomplish worth while results. It usually requires three years to eliminate enough visible smoke in a large community so that the general public agrees that there is a decided improvement. Elimination of dust and fumes takes longer. Probably five years would be required to make a substantial reduction in dust and fume emissions.

Many people think that the way to clean up air pollution is to pass a strict law and then prosecute all offenders in court. Experience has shown that better results can be obtained by securing cooperation than by use of the "big stick". There must be an Ordinance and the few who refuse to cooperate should be prosecuted. In the long run, however, a properly organized administered cooperative program will obtain better results. The efforts must be continuous. If all the sporadic misdirected efforts to reduce air pollution had been made continuous more cities in America would have clean air today.

NEW PUBLICATIONS

Beginning in January, 1953, the Air Pollution Control Association will publish *APCA News*, a monthly magazine devoted to current news and developments in the field of air pollution.

There has long been a need for a publication which will bring news to the members faster than a quarterly such as *Air Repair*. *APCA News* will fill the bill, we hope. And if there is any emergency spot news breaking between issues, the Secretariat will still spin the mimeograph machine to bring you such news as fast as possible.

Air Repair will remain a quarterly, and will be restricted to articles of a technical nature, whether written in technical or lay language.

The Editor welcomes contributions, tips, and suggestions for both publications, and earnestly hopes that the membership will keep him informed of developments in their areas and their fields.

THE PROBLEM OF SMOKE IN BUENOS AIRES

by Dr. Mauricio Rubin
Director of the Buenos Aires Therapeutic Institute of the National Ministry of Health
Member, Air Pollution Control Association

The city of Buenos Aires, capital of the Republic of Argentina, is polygonal in form and is surrounded by heavily populated suburbs with an average population of nearly four million inhabitants.

At the end of 1939 Argentina began an era of industrialization brought about by the last World War. By the end of 1943 the country had made gigantic strides toward industrialization, for during the most crucial part of the war it had transformed itself from an importer nation into an exporter.

In a few years Argentina has undergone a complete change, having created industries and manufactures from all the natural resources around Buenos Aires, as well as having increased its production of the essential materials.

As a result there is, around the city of Buenos Aires, a belt of plants which scatter the greatest part of their waste over the city. It is imperative that immediate steps be taken to introduce anti-pollution measures to assure the purification of the atmosphere and to maintain the beauty of this great South American city, whose population is surpassed only by New York and Chicago in the Western Hemisphere.

The sanitary laws which have been in force until the present time are those of the municipalities and cannot be enforced in the areas outside the exact city limits.

In the suburbs, real industrial cities like Avellaneda, which is separated from Buenos Aires as New Jersey is from New York, by a narrow river, have formed small improvement societies to study such problems.

Although an inhabitant of Buenos Aires will have an opinion on the problem of smoke, it will not coincide with the opinion of a citizen of Manchester, not because the condition has not yet reached so grave a state, but because our problem will be much greater than in other countries if immediate remedial measures are not taken.

The great demand for fuels has necessitated the acceptance of inferior goods, furthermore, machinery has not been replaced by better known methods. In a study carried out by the writer, it was shown that in the battle against smoke being undertaken by the Republic of Argentina, mechanical precipitators will have to be considered, since high tension electricity cannot be depended upon.

The consumption of electricity has been proportionate with the growth of industry, and the supply of energy will be lessened by its unavoidable use, since we are unable to divert the use of electricity for the above-mentioned objective.

Another important problem which arises not only from the manufacturing area, but from the accidental phenomena of the particular city, is the smoke and soot which are given off by the heating and hot water systems of homes and apartments.

Without a doubt our fuel problem is urgent, for during the war, we have had to change from oil-fired boilers to coal, or to firewood, regardless of quality. Under such conditions, heating units that have been constructed for the consumption of oil cannot function efficiently.

We must overlook, in these cases, the infractions committed involuntarily by the owners of the soot-spreading properties, since their arguments will be borne out completely by the aforementioned causes.

Dr. Mauricio Rubin, a 38-year-old Argentinian, received his doctor of medicine degree in 1940. Upon graduation, he practiced in Penna Hospital, located in one of the most industrialized areas of Buenos Aires. In this section, even on sunny days, there was a fog which was dispersed only by strong winds, making Dr. Rubin quite conscious of fog and its problems. He wrote various articles on the effect of fog on health. The national authorities undertook the study and formation of legislation in the battle against smoke in 1946. The effective part of this fight was begun officially in 1950, when all separate organizations fighting air pollution in Argentina were united.

Transportation presents another small problem; electric trolleys will replace other forms of transportation little by little, for, owing to the unsatisfactory conversion of the rolling stock, the Diesel engines throw off, in the very heart of the city, a smoke which we understand is prejudicial to health. This problem is being attacked and the extension and enlargement of the subway is being investigated as a part of a future vast network of transportation.

To sum up, the problem of the struggle against smoke in the city of Buenos Aires and its suburbs, dating from many years back, has been intensified in the extreme since 1943. Owing to the geographic location, the winds, and the topographic situation of the city, this problem was not considered to be of major importance in our country; the favorable natural site of the city and the air currents helped to dispel with ease those noxious fumes, but the great industriali-

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Translated from the Spanish by
Miss Mary Jane Volk
Assistant Librarian, Mellon Institute

Mary Jane Volk is an accomplished linguist, familiar with Spanish, French, and German. She likes to take her vacations in France, Spain, or Latin America. Her hobbies include sewing, cooking, color photography, millinery, and music.

zation at the end of 1943, as well as the increase in population by European refugees, has demonstrated that the great cities of our country must attack this problem on the large scale that other nations have found necessary. Owing to the conditions described and the difficulty of employing electric precipitators, we must consider the use of low cost mechanical precipitators, which can be adapted to many emergency industries.

Another factor which we must take into account in our future plans is the establishment of privileged areas for the location of industries, especially of high grade manufactures. We will establish them in special areas which are best adapted to them from the point of view of natural air currents and which have the inherent properties of soil for the best production results, thus preventing the accumulation of industries in the big cities.

AN IDEA

SMOKELESS AIR, the quarterly journal of the National Smoke Abatement Society of Great Britain, made the following suggestion in its summer issue:

The people of Birmingham, when Queen Victoria and the Prince Consort visited there in 1858, decided there should be no smoke while the royal couple was there, and passed a resolution that no fire should be lighted that day.

Nothing would be more fitting, the journal commented, than that Coronation Day, June 2, 1953 be observed throughout the land as a smokeless day. It is a day given over the rejoicing, and it will need brilliance and color. Why, then, should the sky be obscured with a pall of smoke?

The same reasoning could be applied where Inauguration Day is concerned in our country. It will be a day given over to rejoicing by all those who voted *right*. Can the Cleaner Air Week Committee, with its marvelous ability for getting publicity, arrange something like this on short notice?

ONE BILLION TONS

WITH GROWING population, increasing production, and expanding needs for electric power expected to double the energy requirements of the United States by 1975, coal consumption may reach a billion tons annually or about twice as much as is used today.

Techniques Used in Sampling Particulate Matter in Cincinnati

by ED ALPAUGH, *Assistant Engineer*
Bureau of Smoke Inspection, City of Cincinnati

Given at the Last Central Section Meeting, APCA, Louisville, Ky., Sept. 18-19, 1952

THE MEASUREMENT of airborne solids deposits by the use of dust fall jars has been in effect in Cincinnati for more than 20 years. The data collected over this period of time is valuable in that it may be used as a kind of yardstick with which to compare particulate matter deposits in localities and during specified time periods.

It also serves to indicate any abnormal emissions of which we might not be aware. For example, in the dust fall survey of the last few months, the figures for combustibles have remained normal, but in certain localities the figures for incombustibles have increased by a large amount.

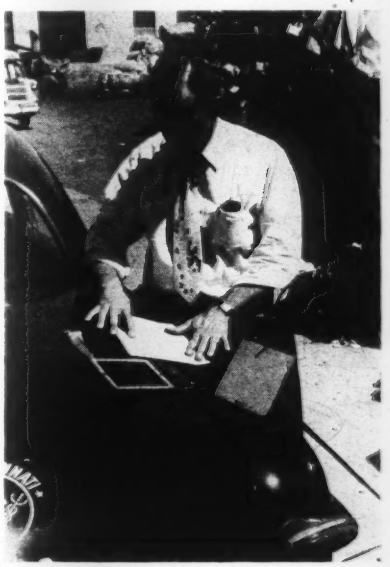
In some sections of the city the deposits have been more than five times the normal tonnage. The particulate matter is a very fine white material, which, when observed in the collecting liquid, looks like a growth.

Because of the nature of the deposit, the Bureau of Smoke Inspection has had no complaints, even after publication of the excessive tonnage figures in a local newspaper. Analysis of the material by the Kettering Laboratory of Cincinnati shows it to be either plaster of paris or gypsum.

Much has been written on the use of dust fall jars for collecting particulate matter, and only a few statements pertinent to the City of Cincinnati will be presented here.

Approximately one pint of a mixture of glycerine and water, about 20 degrees Baume gravity, is placed in a 5 inch diameter by 11 inch high glass jar and exposed in a selected location for a month. There are 20 stations in an area of 73 square miles ranging from the hilltop suburbs to the highly industrialized sections. Results are reported monthly in terms of tons per square mile, and total tons of combustible, incombustible and total solids deposit.

Realizing the limitations of the dust fall jar measurements, the Bureau of Smoke Inspection of Cincinnati has undertaken a much broader air pollution



Inspector Ed Korte preparing adhesive paper patch for exposure.

evaluation program. A few primary objectives were selected at the beginning of the program to furnish a goal toward which to work. The first objective is to conduct an investigation of the general air pollution conditions in the atmosphere above Cincinnati and surrounding territory to determine the following:

1. The total quantity of air pollution over the city, and the changes in this quantity from time to time.
2. The physical and chemical nature of said air pollution.
3. The sources, factors and conditions, including weather, which influence the conditions of the atmosphere over Cincinnati.
4. The influence of air pollution from neighboring communities on the atmosphere of the city.
5. The influence of air pollution on the general well-being of the community.
6. The economic influence of air pollution on the city.

Among other objectives, not necessarily listed in order of importance, are the development of instruments and procedures to accomplish the first objective, the compilation of comprehensive records

and data, and the determination of point sources of pollution and methods of control for these sources.

A rather limited budget makes the selection of sampling instruments and laboratory equipment a problem. After consideration, the automatic air sampler, produced by the Research Appliance Company of Pittsburgh, was selected to be the basic instrument for our program.

The air sampler was developed by W. C. L. Hemeon, Engineering Director of the Industrial Hygiene Foundation of America. It is relatively inexpensive, yields samples that can be handled by both physical and chemical methods, and is suitable for continual operation.

After selection it became necessary to determine the capabilities and limitations of the instrument. In order to determine the effect of location two samplers were operated side by side at the same flow rate with the inlet tubes on opposite sides of a sixth floor window with a south exposure. Evaluations of the "dirt shade" with a reflectance meter never varied more than three scale readings.

Next, a comparison was made between a sampler exposed on the roof of the building (six stories high) and the sampler on the sixth floor. In this case the protective influence of the side of the building was very noticeable.

Reflectance meter readings on the samples obtained on the roof were usually 10 to 20 scale divisions higher although the overall picture of maximum and minimum readings for specific time periods was identical. When the wind was from the south the variation between samplers was much less. As a final check, both samplers were placed on the roof, approximately 25 feet apart, and again, the results were almost identical.

Further experimentation showed that a small variation flow rate did not appear to be too critical. Because of the build-up of particulate matter on the paper the flow rate decreases with time, and it is difficult to determine exactly the total volume sampled.

However, a flow rate of plus or minus 10 per cent gave very little variation in readings. It was found that if the diameter of the circle through which the air is drawn is reduced by a quarter of an inch, the dirt shade readings will be increased by 30 to 50 per cent, depending upon the dust loading in the atmosphere.

An old battery box, a piece of pipe, and cement make an excellent all-purpose stand.

When the automatic air sampler was first placed in use, a piece of glass tubing bent at a 90 degree angle was used as the inlet. Over a period of time dust particles settled out in the bend and acted as a primary filter, thus giving lower readings than should be expected. To overcome this, a straight piece of glass tubing was used in a small settling bottle so that rain and large agglomerated soot balls could not be deposited on the filter paper.

Before discussing results obtained with the automatic air sampler, it would be well to discuss methods of recording meteorological data and sampling data. Weather plays an important role in the dispersal of atmospheric pollutants. Wind velocity and direction are the major factors and must be recorded in any study of air pollution.

The Bureau of Smoke Inspection was fortunate in securing from the Weather Bureau through the efforts of A. W. Walstrom, official in charge of the U. S. Weather Bureau in Cincinnati, the loan of a set of instruments for recording wind velocity and direction.

These instruments were removed from the Carew Tower because at this location the turbulent wind conditions are not representative of the true air conditions over Cincinnati. The Bureau of Smoke Inspection building at 417 Lincoln Park Drive affords an ideal location to pick up weather data which affects the basin area. The instruments are at approximately a 600 foot elevation, 100 feet above grade, and about 27 feet above the roof (Fountain Square, in the heart of the downtown district, has an elevation of 525 feet). There are no local obstructions, thus the exposure is ideal for wind velocity and direction.

The day is divided into four time periods—midnight to 6:00 a.m., 6:00 to noon, noon to 6:00 p.m. and 6:00 p.m. to midnight. With this procedure, the triple register affords an excellent picture of total miles of wind and direction for each period.

The "dirt shade" of each spot is obtained with a reflectance meter. In order to have a standard with which to work, clean filter paper is arbitrarily given a value of 100 and the dirt shade is obtained by subtracting the actual reading from this value. Consequently, a reading of zero would be white, and a reading of 100 would be black.

Getting the program set up and proofing the instruments has accounted for a considerable portion of the first year of the program. However, over a five-month period, data obtained with the automatic air sampler present a definite picture. It shows that the overall level of particulate matter follows the same pattern in all sections of the city.

The only difference being that the level is much lower in the hill-top suburbs. A plot of total miles of wind per six-hour period in conjunction with a plot of the dirt shade reading for each six-hour period shows almost without exception that a large number will result in a high dirt shade reading.

Ordinarily 50 or more miles of wind per six-hour period results in a dirt shade reading of 15 or less. If the total miles of wind per six-hour period is less than 20, the dirt shade reading will usually be 40 or higher.

If there is rain during the period in which there is not much wind, the dirt shade reading will be somewhat lower. Variations in time periods themselves are very similar. The early morning period (midnight to 6:00 a.m.) usually gives the highest reading and early afternoon (noon to 6:00 p.m.) the lowest. This same pattern appears to be common in

other sections of the country and also in Great Britain., Without exception, when a temperature inversion is observed in the early morning hours, the dirt shade reading for the midnight to 6:00 a.m. period will be very high.

Aluminum foil, coated with vaseline and weighed before and after a 24-hour exposure, has given high results when compared with a dust fall jar on the same location. Over a period of four months, the average monthly tonnages recorded for the aluminum foil have been double the tonnage recorded for the jar.

Other techniques experimented with have been a microscope slide with an adhesive surface and wooden blocks with the four sides covered with paper having a white adhesive surface. The blocks are patterned after the vaseline coated glass bottles devised by Mr. W. L. Wilson, Chief of the Bureau of Industrial Hygiene of Cleveland, but have the advantage of ease of handling in that the layer of paper covering the adhesive surface may be left on until the sampling location is reached, and then peeled off.

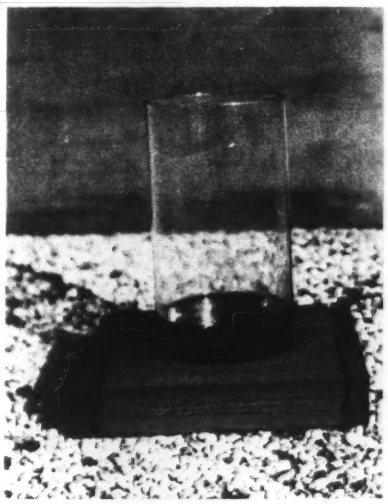
Both the bottles and blocks offer promise as a method of roughly estimating the direction of a dirt source since the four faces are perpendicular to the plane of the wind. The blocks have also been used with a dark adhesive surface in an effort to locate the source of the white particulate matter mentioned earlier in this paper, but no results are available at this time.

The microscope slide is used for making dust counts. However, it has not been possible to get a correlation of the dust counts with the dirt shade readings. The microscope itself has been of great value in identifying complaint samples brought in by the inspectors, and will be used more and more as the program progresses.

Some work has been done with a cylindrical support made of chicken wire and covered with cheesecloth. Reflectance meter readings are taken on the cloth before and after exposure, with exposure periods varying from 24 hours to one week. Rainfall interferes in that it washes the cloth relatively clean and prevents the development of conclusive data. There is some possibility that in reviewing these data, it may be shown that one specified time period was cleaner or dirtier than another.

Visibility readings and relative humidity readings are taken at 8:00 a.m., noon, and 4:00 p.m. These are recorded along with observations of general weather conditions, temperature, degree days, miles of wind and direction (including fastest mile), inches of rainfall, dust count, and aluminum foil weight along with any pertinent remarks such as inversions or other unusual weather conditions.

The Weather Bureau has several temperature recording stations located at different levels throughout the city, and, using the data from these stations, an attempt has been made to record inversions. Results show that it takes a particularly heavy inversion to produce a picture that will show up in these records.



Dust fall jar and holder.

Nevertheless, there has been enough correlation between these temperature data and the dirt shade readings of the midnight to 6:00 a.m. period to make these observations rather important. Of course, to obtain a true indication of a temperature inversion greater differences in elevation are required.

Correlation of weather data with dirt shade readings has turned out to be a veritable jig saw puzzle. The only consistency observed has been with total miles of wind per period.

Analysis of wind directions over a three month period showed that when spots were dirty, 38.6 per cent of the total miles of wind were northerly, 47.3 per cent southerly, 3.7 per cent east, and 10.4 per cent west. When spots were clean, 50.6 per cent of the total miles of wind were northerly (an increase of 12 per cent), 42.1 were southerly (a decrease of 5.2 per cent), 1.2 per cent east (a decrease of 2.5 per cent), and 5.1 per cent west (a decrease of 4.3 per cent).

From these figures, a comparatively large increase in northerly winds coupled with lower dirt shade readings would indicate that a wind from the northern quadrant of the city carries less particulate matter than winds from other directions.

Steel mills to the south of the sampling station were shut down during this period so that the correlation with winds from the south is not a true one. Emphasis should not be placed on the figures presented, but rather on the possibility of using several samplers to determine the influence of air pollution from neighboring communities on the atmosphere of the city. Further comparisons of dirt shade readings with other data is not conclusive.

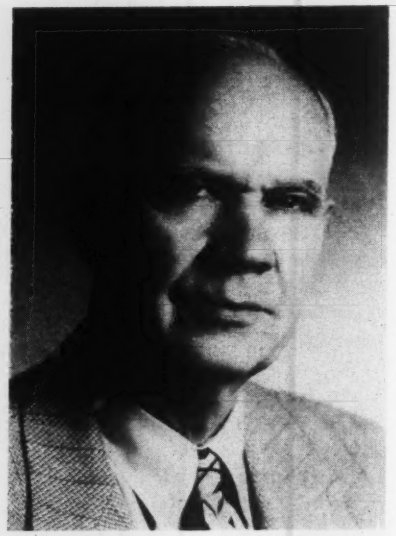
It must be emphasized that much more data is required for proper interpretation than used for the above figures, and that the primary reason for quoting these figures is to give some idea of the preliminary aspects of the air pollution evaluation program of the City of Cincinnati.

Although the data collected may not be adequate, it does represent an impressive amount. As time goes on, the recording, interpretation, and filing of this material will become a problem of major importance, and even in the early stages of the program, these necessary duties account for a large portion of the total time expended.

Instruments for Automatic Air Pollution Measurements. W. C. L. Hemeon. *Proceedings of A. P. S. P. A. A., 1951.*

Considerate!

WHEN housewives complained that grit from sandblasting operations at the First Presbyterian Church in Franklin, Ind., soiled washday clothes, the sandblasting contractor promised that operations will be halted each Monday - traditional washday. And if it rains on Monday, he promised, the work will be stopped on Tuesday!



Prof. Richard G. Tyler, author of the article on Seattle's air pollution control report, is a distinguished educator, belonging to many professional societies. At present the dean of engineering of the University of Washington, he has served for the past 22 years as professor of sanitary engineering there. In private engineering practice, Prof. Tyler was consulted on water, sewage, and air pollution problems, and served as an expert witness in a law suit involving a water shed study. He has written numerous papers for technical journals on industrial research and sewage and water supply problems.

SEATTLE POLLUTION REPORT RELEASED

by RICHARD G. TYLER, *Professor of Sanitary Engineering*

Reprinted from the July, 1952 issue of the *Trend*, University of Washington Quarterly, with permission

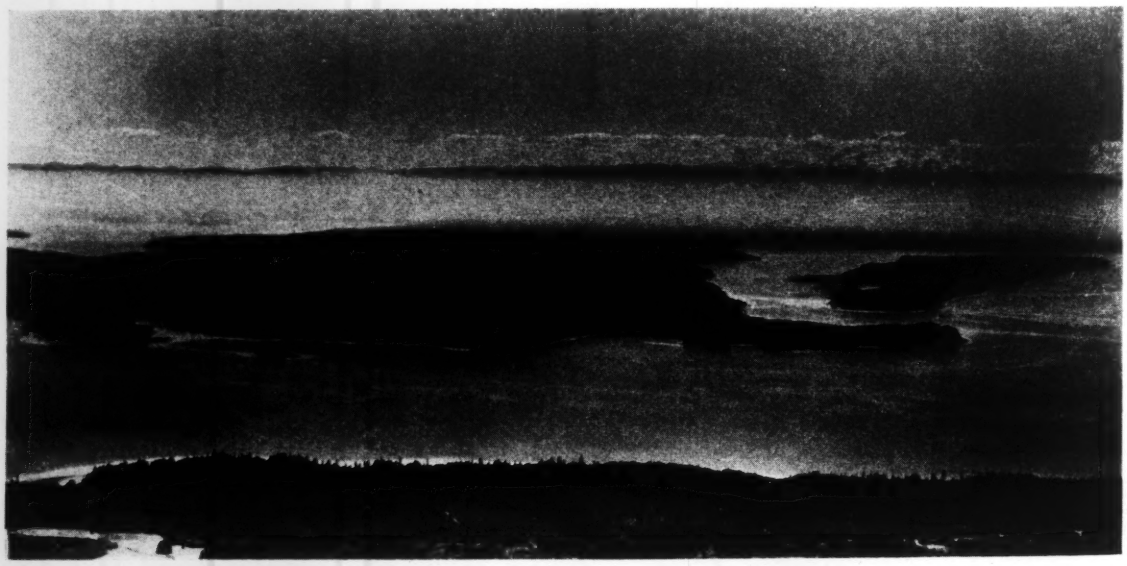
IN THE TREND for April, 1952, Ross N. Kusian, in describing the various activities of the Environmental Research Laboratory being carried out under his direction, discussed in some detail the various studies then in progress on the Seattle air-pollution investigation. Now that the report has been submitted to the City Engineer, Ralph W. Finke, at whose request the study was made, a brief summary of the findings and recommendations made therein may be of interest to the readers of *The Trend*.

The air-pollution problem is both local and regional in nature. Locally, smoke, fumes, and dust originate principally in two major industrial districts, one lying south of Jackson Street and the other extending along the Ballard-Lake Washington Canal and along the shores of Lake Union. Thus industry has an industrial axis extending in a general northwesterly-southeasterly direction for almost the entire length of the city's major dimension, with some attenuation in the retail business district. Seattle is unfortunate in not having expert planning advice in localizing its industrial development in accord with a more concentrated and logical plan. The limited area still available for industrial development in and adjacent to Seattle should make its air-pollution problems easier to control in the future than in some other Washington cities having larger areas available to industry.

The regional aspects of the problem arise from the fact that with the anticipated increase in industrial development of the Puget Sound Basin, a greater blending of the air pollutants of its cities and towns will occur. Viewed from a plane 2,000 or 3,000 feet over Seattle, industrial smokes from Bellingham, Everett, Seattle, Tacoma, Shelton, Port Ludlow, and Port Angeles, may be seen flowing southward or northward depending upon the seasonal wind directions. Seattle gets both smoke and odors from Tacoma and Everett as the wind is in the south or north. Obviously, therefore, the air-pollution problem should be attacked in all of these communities if it is to be satisfactorily controlled.

The dustfall remains unusually constant throughout the year, with the heaviest fall shifting southward under the northerly winds of summer, and returning northward with the winter's southerly winds. The filter disks which are darkened more by the carbon in smoke than by its dust content, are distinctly darker in winter than in summer.

Aerial view looking eastward over Tacoma on June 20, 1951. The top of the smog bank is probably at 2,500 ft. elevation.



The Seattle and Los Angeles meteorological characteristics which account for their worst smog conditions are quite similar in that each has frequent atmospheric inversions. A common type of inversion occurs when ground cooling chills the lower air layers to a temperature below that at a higher level. Since the cold air is heavier it remains below the warmer air and does not mix with it. Thus it and its burden of smoke, etc., envelops the city and continues to increase in concentration for as long as the inversion lasts. Such inversions, with their pollutants concentrated during several days without the usual dissipation to the upper atmosphere, took 20 lives at Donora, Pennsylvania, in October, 1948, while 5,910 were affected. In the Meuse River Valley in Belgium in December, 1931, 63 people lost their lives, and thousands were affected.

During the year covered by the Seattle study, there were many inversions, two of which continued for five or six days. During such periods the haze becomes dense and the visibility is greatly decreased. They are readily recognized by an early morning low-lying, dark cloud bank over parts of the City. These may be dissipated within an hour or two as the sun heats the ground and its adjacent air and thus forms convection currents which may cause sufficient mixing to dissipate the upper layer of warm air causing the inversion.

An illustrative example of an inversion shows a thin strip of land above the smog and at the level of the bottom of the warm air layer which kept the clouds from rising and the smoke from being dissipated. The top of the smog layer is at the approximate elevation of the inversion as indicated by radiosonde data from the Sand Point Naval Station. I suggest that Seattle citizens watch the smog conditions which usually cover the City only in part so that one hill may have a haze covering while another may be quite clear. This haze is caused, in many cases, by the inversion condition herein discussed which forms an effective lid for keeping the air pollutants confined in the lower air layer. Oil sleeks have been studied by the harbor patrol for which the only apparent cause has been the contact of the water with low-lying smog blankets. That on Lake Washington on March 27-28, 1952, was apparently caused in this way.

Fortunately, the causes of much of the local smoke can be remedied. Residential smoke from oil burners can be eliminated by cleaning and adjusting the burners. As mentioned in the report, there is some evidence of down-grading of fuel oils as more of the lighter fractions are being removed at the refinery. More air is required to burn these oils without smoke. Coal burners account for much of the residential smoke since locally burned coals have a high volatile content which makes smokeless burning difficult. But here also smoke can be held to acceptable standards.

Much of the industrial smoke comes from the burning of wood wastes or what is usually called hogged fuel. This material is made up of miscellaneous wastes from lumber mills and woodworking industries and includes pieces of board, shavings, saw dust, sander dust, etc. from the different kinds of timber grown in this area. These contain varying amounts of moisture, a great range of size, and are often mixed with no uniformity. To try to feed a furnace uniformly with such fuels so as to provide constant conditions for burning is obviously impossible. Also, since these differences in moisture content and in size and character of wood demand differences in the air supply, temperature of burning, etc., the use of varying admixtures of these various elements makes it impossible to burn the wastes completely and with the best air-fuel ratios. Furthermore, the fuel is relatively inexpensive so proper methods for ventilation and combustion are not provided. It is not surprising therefore that hogged fuel causes so much of the total smoke produced in Seattle. Adequate grading, drying, and uniform feeding of this fuel would do much toward reducing the smoke now being produced through its use. Over-fire air jets in the Dutch ovens employed would do much to effect satisfactory combustion.

The development of a use for these wastes as in the manufacture of some of the soft-or hard-wood products that can be made from them would go far toward eliminating the smoke they at present produce. In the meantime, better draft regulation and uniform feeding of the graded and dried fuel is capable of meeting the usual requirements for allowable smoke emission.

Fortunately, Seattle does not have toxic materials such as fluorides in its atmosphere. A very thorough test series resulted in this conclusion. Other gases such as SO_2, CO_2, etc. are present as in all cities. The former under some conditions produce sulfuric acid which corrodes steel structures and attacks stone and concrete. It should therefore be kept to a minimum.

The Seattle Air Pollution Report concludes with the following recommendations:

1. That an Air Pollution Control ordinance be set up by the City of Seattle defining air pollution, establishing a Division of Air Pollution Control in an appropriate City Department, and outlining its duties and responsibilities.
2. That a study of all smoke, fumes, or dust-producing plants in the city should be made by the Division of Air Pollution Control and these plants should be notified of the manner and extent of their failure to comply with the requirements of said ordinance. Said plants may seek the advice of experts in this field, of which there are an ample supply in Seattle.
3. That a city-wide educational program be set up such as discussed above, in which the widest possible cooperation should be secured and adequate expert leadership provided for informing the people and plant management throughout the city concerning the air pollution existing in Seattle together with its significance, cost to the community, and method for its reduction.

CAPSULES

NEXT to being young and pretty, the best is to be old and rich.—William Feather. When your ship comes in, the government sees that it is docked.—Earl Wilson. All progress is based on the universal desire of every organism to live beyone its income.—Samuel Butler. She has quite a speech impediment. She has to stop to breathe.—Hudson Newsletter. He's saving up money to buy something he can't afford.—Clyde Moore.

Leonardo Da Vinci – Smoke Regulation Engineer

by CARL G. SWANSON, JR.
Smoke Regulation Deputy
Omaha, Nebraska

THE RENAISSANCE, beginning in Italy in the 14th Century and spreading gradually throughout the 16th Century to other countries, is extremely rich in the historical origin of modern scientific thinking. During this period there lived many geniuses who contributed materially to the great revival of learning in the arts and sciences characteristic of that period. But perhaps none was of such breadth as one, Leonardo Da Vinci (1452-1519). Considering the fact that this man began at the age of thirty teaching himself mathematics and Latin, it is staggering to the imagination to review the scope of his experimentation. From his diaries of 5000 pages or so of notes, drawings, painted walls, and a few tables, historians have been able to piece together the life of a most remarkable scientist.

Renowned today specifically for his work as a painter, it should be pointed out that this skill was only a byproduct of his more basic desire of observation and experimentation, and he was, indeed, the founder of the experimental method. In the hire of many kings during his lifetime, he usually offered his services as a builder of war-machines, decorator, and repair man.

His formulations are common knowledge today; yet it must be remembered that the explanation of all laws of nature, no matter how simple they seem in the Twentieth Century, had an origin.

While it is true many of his designs proceeded no further than the drafting board, his visualizations paved the way for later achievements. Ludwig in his *Genius and Character* reviews as follows: "In countless drawings he designed hydroplanes, the first parachute, diving bells, and the submarine . . . He built machines for sawing, spinning, shearing, washing, pottery making . . . He constructed artesian wells, all sorts of mills, scales, the concave mirror, and the pendulum . . . Instead of theorizing with the humanists over the problem 'Is warmth a substance?' he drew his conclusions by comparing the weight of an object when cold with its weight when at white heat . . . He observed the accelerated motion of a falling body . . . and found the law two centuries before Newton . . . he constructed the block and tackle and was the first man since Archimedes to record the principles of the lever . . . he developed the law of the conservation of energy . . . founded the science of paleontology . . . discovered the law of virtual velocity . . . the principles of gyration and the vortex, and the law of communicating vessels. He was the founder of hydrostatics and of the entire science of hydraulics. He understood the undulatory motion of the sea, and applied its principles of transmission and reflection to light and sound . . . explained the echo and the vibration of overtones . . . "

In one of his diaries he impressively noted "Il sole non si muove." (The sun does not move). It has been said that he advised Columbus with the following equivalent—Go ahead, Chris, you will not fall off.

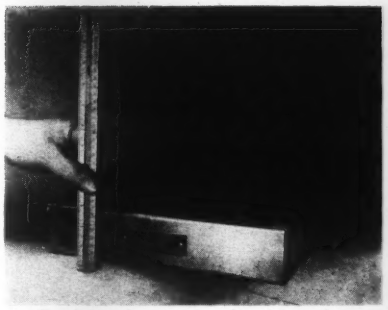
With every object and motion of nature subject to his keen eye of observation and adept hands of experimentation, it was 'natural' for the problems of combustion to occupy his scrutiny. Leonardo Da Vinci invented the modern chimney. While the effect of some sort of 'vapor outlet' had been recognized before his time, he was the first to record improve-

The Mona Lisa hovers benignly over Carl Swanson, author of this article. He is showing Herbert H. Ulrich, his boss, some da Vinci lore.

ments in combustion through the use of 'space.' True, his diary shows no record of such items as optimum stack velocity, draft gradient, or flue area vs. volume of combustible products; but he made conscious the principles of draft. (How could he quantitatively determine these things? He forgot to invent the manometer as we know and use it today.)

Merejkowski in his *Romance of Leonardo Da Vinci* relates the following tale. Da Vinci while working on *The Last Supper* in Milan was suddenly called from his work by the Duchess Beatrice, wife of Il Moro, the powerful Duke of Milan. "Let us hurry. It seems that the kitchen chimneys are smoking," were the words of the messenger. Thereupon the artist left his work, returning after correcting the disturbance.

Thus is implied this man's cognizance of the principle of 'overfire air' and a smoke regulation engineer was born.



Catalytic element, on the order of an air filter mat.

Paint Company Beats Odor and Fume Problem With Special Measures

by MARTIN E. SCHLEICHER, *Technical Director*
McDougall-Butler Company
Buffalo, New York

Government at all levels is placing increasing emphasis on air pollution control. To avoid restrictive legislation, to maintain good public relations, and to assume its full share of responsibility for corrective measures, all branches of industry are constantly on the alert for air pollution control equipment designed for specified needs. The problems connected with the collection or disposal of fumes and vapors liberated during various types of industrial kettle cooking operations has been of serious concern in a number of cities in recent years.

IN MAY, 1950, the McDougall-Butler Company, a manufacturer of varnishes, enamels and paints, moved to a new location in Buffalo. Located nearby is a hospital, school, residential district and modern clean factory buildings. A decision was made to delay all "cooking" operations until a good means for elimination of obnoxious fumes was available.

During the next 12 months a survey of literature was made and other plants, employing various methods of fume elimination, were visited. Cooperation of other paint manufacturers in these trips was complete. Systems employing different washing methods, different devices burning the fumes and combinations of both were inspected. Some worked well and some didn't. Finally a set of specifications, embodying the good points of the various types, was drawn up. This specification was as follows:

I—Fume Elimination.

Should be complete, giving absence of recognizable fumes by either sight or smell.

II—Ease.

1. To require as little supervision as possible and capable of being operated by regular production personnel.
2. To have no waste products needing disposal.
3. To require no special solutions or chemicals.
4. To need little or no cleaning of its parts.

III—Safety.

1. To operate in a manner which will not be responsible for or conducive to causing flashes in the kettles or any duct work.
2. To be capable of being equipped with safety devices which would prevent power failures, etc. from interfering with the successful completion of the batch being processed.

IV—Economy.

1. Should be as economical in installation and operation as possible, consistent with conformity to the other parts of the specification. In this regard we include floor space used and horse power of operating motors.

V—Appearance.

Since we would be operating a new plant, we desire the unit to be as neat as possible. An additional point that, if possible, it should not use any large, tall stacks which would call attention to itself and our operations.

After due consideration was given to all facts, it was decided to place into operation a unit designed and built by the Catalytic Combustion Corporation. This unit has been in operation for some time and has completely consumed the fumes generated during the processing of different types of oleoresinous varnishes, alkyd resins and bodied oils. The varnishes cooked included phenolic, maleic and ester gum varnishes made with oils such as soya, linseed, cicoil and chinawood oil. This unit as described and illustrated is designed for two 1000 gallon kettles.

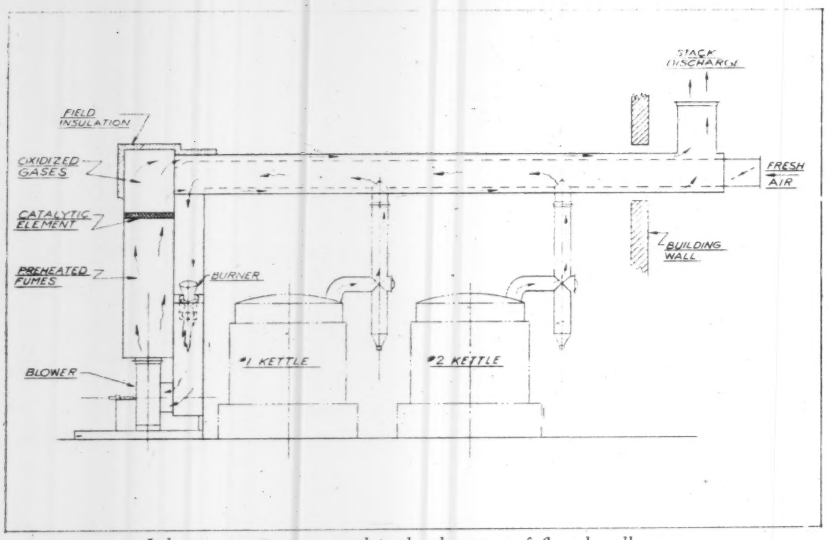
The system functions according to a physical law that a combustible gas, regardless of its dilution, so that it might ordinarily be classified as non-combustible (in the mixture), is consumed when exposed to the surfaces of a suitable catalyst. This application has been utilized for many years in the manufacture of gas detection instruments and in oxidation reactions in the chemical field.

This is a new application, however, for this particular need. The unit employed by McDougall-Butler is, indeed, the first Catalytic Combustion Company unit employed in the paint and varnish industry for closed kettle operation.

Simply by the presence of the catalyst, the oxygen in the air and the combustible gases unite at very low temperatures, around 500° F., to form colorless by-product gases whose composition is mainly carbon dioxide, water vapor and the extra nitrogen left from the air. Heat is generated by this low temperature combustion and consequently the oxidized gases leaving the unit are at higher temperatures than they were when they entered.

Equipment

The Catalytic Combustion Company system may be regarded as two related sections. One section is the combustion unit itself (see Photograph No. 1). The other consists of a double manifold, serving the dual purpose of collecting the



Laboratory apparatus used in development of fly ash collectors.

Photo No. 1. Combustion unit, with double manifold, serving the dual purpose of collecting the fumes and discharging the by-products of combustion.

fumes and discharging the by-products of the combustion.

This manifold appears in the upper right hand corner of Photograph No. 1, as well as in the upper section of Photograph No. 2, which shows a closed kettle. A flow diagram illustrating the relationship of the two sections is shown in the drawing. Fumes generated during the cooking process are conducted into the inner duct of the manifold as shown in Photograph No. 2. Here they are diluted with fresh air and carried through the preheating burner to the combustion unit. The preheating burner is necessary only to bring the mixtures of air and fumes to the catalytic ignition temperature of approximately 500° F. Upon passage through the catalytical active elements, complete oxidation of the fumes occurs.

The catalytic element, shown on Page 27, is constructed similarly to a metallic air filter mat. It consists of heat resistant metallic ribbon processed to provide a maximum of surface area, enclosed between heat resistant alloy screens mounted in an alloy channel frame.

Metals of the platinum family are applied to all surfaces of this mat. In this construction, a tremendous amount of surface are is provided for the chemical union of oxygen and the gasified combustibles in the fumes to unite.

Theoretically, a catalyst does not enter itself into a reaction and therefore would have an infinite life. In practical application, however, nothing lasts forever and it is expected that perhaps after 5,000 to 15,000 operating hours the elements will require reactivation for extended use.

Inspection was made of the catalyst after approximately 50 and 300 hours and no visual signs of deterioration were evident. Repeat temperatures at the same level as initially run are still operative and giving complete absence from fumes, thus indicating the continued high level of activity.

After discharge through the catalyst at temperatures which depend upon the amount of combustibles in the fumes, the oxidized gases then pass through the outer duct of the combustible system to the stack outlet.

Double manifolding serves a twofold purpose. First it retains the vapors from the kettle in a gaseous state and prevents condensation in the duct system.

Secondly, it acts as a heat exchanger, utilizing the heat generated by the oxidation of the fumes to help preheat the colder fumes, and reducing burner consumption to a minimum. After processing a variety of materials, in which time the catalyst was in operation approximately 300 hours, examination was made of the inner duct. A complete absence of condensation was noted.

The fresh air damper leading to the inner duct of the double manifold section, shown in the drawing, is given an initial adjustment when the unit is first placed in use. With both kettles at maximum fuming rate, sufficient air is drawn into the system to maintain a fume-air energy concentration no greater than approximately ¼ of the lower limit of flammability. The mixture, when passed through the catalyst, should provide a maximum temperature rise of approximately 550° F. and, at the same time, provides an adequate factor of safety against a possible flashback within the system.

This fresh air damper we have is also equipped with an automatic operating mechanism. While not necessary for safety reasons, it was connected so that this damper could be easily operated from the inside of the building.

When loading dry material into the kettles, or for other reasons, with the Catalytic Combustion unit in a non-operating state, we would desire to have any such dusts discharged to the outer air rather than to the cold surfaces of

Photo No. 2. Closed kettle.

the units. This is easily accomplished by opening the damper so that a direct flow is obtainable to the outside air rather than to the system itself. In addition, this enables us to easily open the damper if anything should occur such as motor blower failure, etc. This is an easy method of insuring successful completion of the process batch.

The combustion unit itself is provided with complete automatic, proportioning temperature control as well as all necessary instruments to provide protection against failures of the preheater burner, fan or electrical current supply. Minimum and maximum temperatures limiting cutoffs give secondary protection against abnormal operations. The types and arrangements of safety devices are those which are normally specified by fire insurance underwriters for handling of combustible type gases.

Method of Operation

Starting operations require only the execution of the following simple steps:

1. Close fan switch.
2. Close control switch.
3. Depress push button which lights the pilot and main burner. In general, no attendance is required during the day's operations except an occasional check of the catalyst temperature is made.

Standard practice consists in maintaining the system in operating condition throughout the cooking cycle until the kettle charge has cooled to the point where no visible fumes are generated or until the kettle contents have been discharged. Then the fan and control switches are opened, thus shutting down the system.

As previously noted, if earlier stoppage of the combustion unit is desired, a switch can be operated to completely open the outside damper.

Performance

Materials processed included boiled oils, medium and long soya and linseed alkyd resins and miscellaneous varnishes. Data has been taken on these and some representative cooks are reproduced below in graphic form.

If we hold certain data constant (i.e., burning gas rate, blower capacity and air inlet) it becomes evident that the distance between the entry and exit curves is actually a "rate of fuming" curve, and is somewhat proportional to the speed of the chemical reactions that take place in the kettle. It is also true that the area (between the curves) is proportional to the weight loss of combustible matter during the cook.

Analytical examination of the effluent gases has not been made. We have been visited by representatives of oil processors and other paint concerns. Their results based upon their smelling the effluent gases during one of these cooks might be noted as follows:

Color—None
Recondensible areosols—None
Condensate inside stack—None
Eye irritants—None
Odor—Smells like a gas burner on a kitchen stove.

Our own data indicate that with gas of 900 BTU at 72c per thousand cubic feet our operating costs are approximately 25c per hour, when operating one kettle. Since the amount of gas burned is lessened by the amount of combustible fumes passed through the catalyst (to keep a pre-determined temperature) it would be expected that it will cost less to operate two kettles simultaneously.

Conclusions

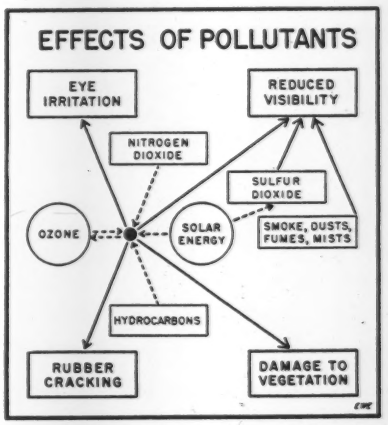
Management has assured itself that our varnish and resin operation can cause us no trouble from the point of nuisance fumes. Our operation is not noticeable by sight or smell and economically is within the complete specifications which we laid down as an objective.

OZONE ASSUMES SIGNIFICANT ROLE IN SMOG

by GORDON P. LARSON, *Director*
Air Pollution Control District, County of Los Angeles

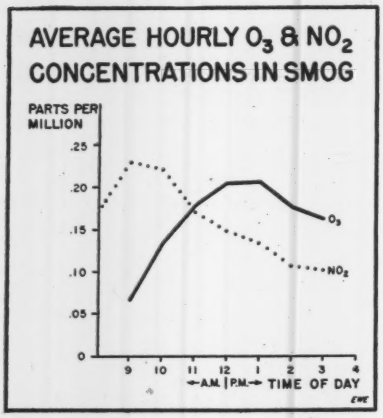
THE REACTIONS by which ozone is formed when smog occurs in Los Angeles have been under extensive investigations in a recent series of experiments. Dr. A. J. Haagen-Smit, consultant to the Air Pollution Control District, and his colleagues at the California Institute of Technology, have shown that normal aldehydes, *viz.*, n-butyraldehyde, branched-chain acids, *viz.*, diethylacetic acid, and certain hydrocarbons, *viz.*, 3-methylheptane, in the presence of oxides of nitrogen and sunlight will produce ozone. Identification of this product of the reaction was made by the cracking effect produced on bent strips of rubber and confirmed on the infrared spectrophotometer and mass spectrometer. This work is of interest in furthering the understanding of the reactions of various pollutants in the atmosphere and may be of value to tire manufacturers throughout the United States.

Rubber chemists have been aware of excessive rubber cracking to the sidewalls of tires in Los Angeles and other areas. This damage has been attributed to ozone. The studies to completely evaluate the differences in the ozone concentrations in several areas where this condition is suspected have been spasmodic and inconclusive. The lack of convenient chemical techniques for measuring ozone in the atmosphere has prevented the collection of sufficient data to support many of the several theories advanced to account for high ozone cencentrations in various areas.



General diagram showing how pollutants in the Los Angeles atmosphere contribute to smog effects.

During an extensive air sampling program in September and October of 1951, ozone was measured for periods of intense smog. Strips of vulcanized rubber, which had been calibrated in the laboratory on a time-concentration basis, were used for this purpose. The average time necessary to produce initial cracking along the strained area of the strips during smog-free periods is 40 to 60



Typical fluctuations in ozone and nitrogen dioxide concentrations in Los Angeles when eye irritation occurs during smog.

minutes which corresponds to 0.02 to 0.03 p.p.m. of ozone. On a day of severe smog, rubber samples cracked in six minutes, corresponding to 0.3 p.p.m. The concentrations of ozone measured on an hourly basis were correlated with measurements of other contaminants for the corresponding periods. Although ozone, a powerful oxidizing agent, may also be produced in photochemical reactions involving oxides of nitrogen, the latter also serves as a strong oxidizing agent. Thus, in view of the strong oxidizing components of smog and the fact that considerable quantities of oxidizable material are present when smog occurs, the previously reported experiments on the effects of oxidized hydrocarbons in smog become more significant.

A report to the Association last year on the Los Angeles problem presented evidence supporting the belief that a reaction in the atmosphere caused damage to vegetation and perhaps eye irritation which has been strengthened by additional research during the past year. When ten p.p.m. of gasoline from the fraction boiling between 35° and 90° C. is introduced in a test chamber containing ozone and oxides of nitrogen, pronounced eye irritation is experienced. Concentrations of 1.6 p.p.m. gasoline, 0.4 p.p.m. of oxides of nitrogen and ozone yield definite eye irritation when 50-80° C. gasoline fractions are used and noticeable eye irritation when gasoline fractions below 35° C. are used. The lower concentrations of hydrocarbons, oxides of nitrogen and ozone used in these experiments correspond to the estimated concentrations of materials that exist in the atmosphere on smoggy days.

Experiments in the test chamber, using these same materials, also produce aerosols. A large part of the aerosols collected from the atmosphere shows chemical and physical properties which correspond closely to the aerosols produced in the fumigation work. The aerosol formation is especially noticeable when double unsaturated, ring compounds, such as dicyclopentadiene are oxidized. This additional experimental evidence, combined with the previously reported work on damage to vegetation, gives strong evidence that certain hydrocarbons must be reduced in the Los Angeles atmosphere if the disagreeable effects of smog are to be minimized.

The program to accomplish this has already begun. Sources are being studied and methods for measuring the quantities of specific hydrocarbons are being developed. Not all types of hydrocarbons can be considered as capable of undergoing reactions in the atmosphere to produce the effects found in the laboratory. Certain unsaturated types and branched-chain hydrocarbons produce significant results and must be identified at the sources prior to controls. Gasoline vapor contains smog-forming hydrocarbons, hence, the initial program is directed toward the large losses from major storage and processing facilities.

The proper evaluation of the contribution of automobile exhausts is dependent upon the development of better analytical methods. Additional laboratory work, too, must continue the search for the ultimate identification of the oxidation products which cause the undesirable effects common to smog. Certain of the experimental projects will be carried out by the District's staff, while other phases will be contracted to local universities in accordance with the established policy to utilize available facilities for research on this complex subject.

In the present state of understanding, it is possible to present schematically the pollutants that have been identified and to show the effects of each as the accompanying diagram indicates.

There remains little controversy over the need for controlling smoke, sulfur dioxide, dusts, fumes, and obnoxious odors. The control program has vigorously reduced the contribution of these contaminants to the Los Angeles air during the four years of operation. Smoke has been reduced 33%; sulfur dioxide, 50%; dusts and fumes, 48%; and numerous reports have been made concerning the control of odors from rendering plants, fish canneries, paint and varnish factories and similar industries.

Since the findings on hydrocarbons are relatively new and the losses to the air are involved with a broad aspect of community life, their control will require additional research. There is every indication that reliable methods for accurately measuring ozone concentrations and atmospheric quantities of hydrocarbons will develop from current research. Further studies will lead to a better understanding of the specific oxidation products of hydrocarbons.

Control measures need not await that day, however. It is clear even now that certain volatile petroleum products such as gasoline, in the presence of sunlight and oxides of nitrogen, are responsible for reaction products, including ozone, which are capable of producing some of the effects of smog. Their emissions to the air, therefore, must be reduced to the limits permitted by practical engineering techniques wherever such sources are evident in air pollution problems.

How Smoke Inspectors Can Benefit from Heavy Drinking

From the Rotary Club magazine of Davenport, Ia.:

If you cannot absolutely refrain from drinking, start a saloon in your own home. Be the only customer and you will not have to buy a license. Give your wife $12 to buy a gallon of whiskey. There are 128 snorts in a gallon.

Buy all your drinks from your wife at 40 cents a snort, and in four days, when the liquor is gone, your wife will have $39.20 to put in the bank and will have $12 to start up in business again.

If you live 10 years and continue to buy all your booze from your wife, and then die with the snakes in your boots, your wife will have $46,592 on deposit, enough to bury you decently, bring up your children, buy a house and lot, marry a respectable man and forget she even knew you.

Du Pont—Autobiography Of An American Enterprise

BOOK REVIEW

AMAZINGLY INTERESTING is the story of the Du Pont Company as told in a $5 book published to commemorate the 150th anniversary of its founding. Charles Scribner's & Sons spared no expense to make this an outstanding contribution to our country's commercial literature.

It is a book without an author, as the foreword states, just as the story of Du Pont is a story without an end. But the anonymous writer or writers can take credit for producing an excellent piece of work.

Beautifully illustrated with hundreds of colored and black-and-white reproductions, the book takes the reader from that day in 1802, when masons laid the first stones of a small mill on the Brandywine Creek, near Wilmington, Delaware, to the present, when the company is faced with the many problems that beset a successful titan: bigness, anti-trust action, markets, and incentives.

Colored illustrations include those of such famous Eighteenth Century painters as Rembrandt Peale and Jacques Louis David, as well as Twentieth Century artists John W. McCoy II and Howard Pyle, and photographers of the excellence of Karsh and Knopf.

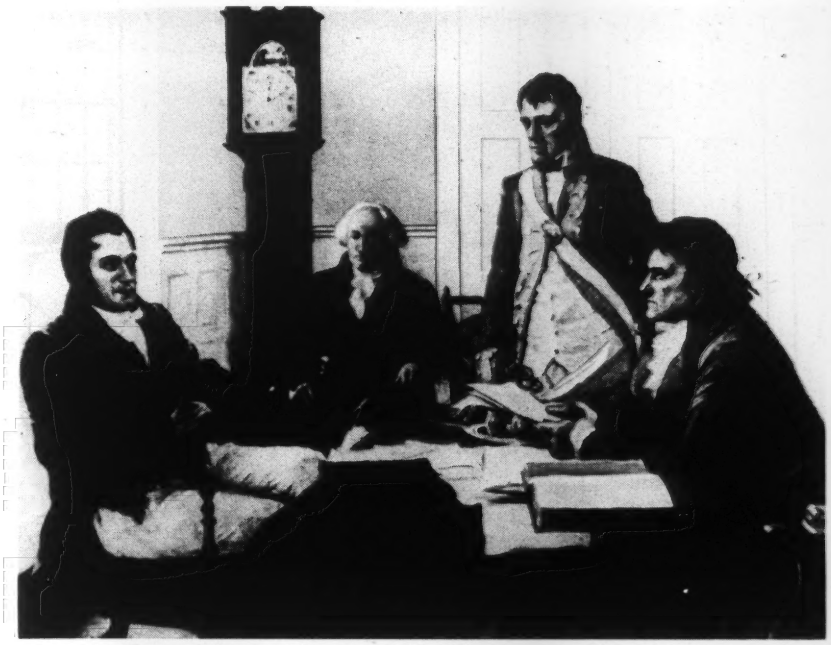
Many of the black-and-whites are reproductions of old engravings and take the reader through the intensely interesting period of the development of America during the 150 years of duPont history.

duPont Comes Here

The book is a skillful blend of pictorial matter and writing, and can be read and reread without tiring. It shows how intimately interwoven was the progress of the country and that of the company.

Eleuthere Irenee duPont was a 29-year-old Parisian who came to America with his father to evade the tyranny of Napoleon I. As a young man he had been apprenticed to the famed chemist, Antoine Lavoisier, greatest scientist of his day, who was superintendent of a government gunpowder plant.

The boy learned the craft of powdermaking and acquired a precise sense of the scientific method. Not long after his arrival in America in 1800 Irenee bought some gunpowder for hunting. As an expert, he was surprised and shocked at its poor quality.



President Thomas Jefferson, right, urges E. I. duPont to go into the powder business. Paul Revere, second from left, was at this famous meeting in 1801 which Stanley Arthurs painted so dramatically.

Good gunpowder was a very real necessity to settlers venturing over the mountains. They needed it for protection against hostile Indians, for hunting, for clearing land of boulders and stumps, and for building roads.

From Poor Grades to Good

American powdermakers during the Revolution had made some acceptable powder, although 90 percent had been bought from France. By 1800 explosions and British competition had put most of the domestic mills out of business. Irenee visited the few survivors, found their methods of manufacturing outmoded, and decided that "such competitors should not be formidable."

President Jefferson was keenly interested in Irenee's plans. He suggested that powder mills be built near Washington, but no suitable site was available. Locations examined near Philadelphia, Paterson, N. J., and on the Hudson River also proved unsatisfactory.

But there was a dam on the Brandywine on the site of the first American cotton mill, which had burned down, and there Irenee bought 95 acres fronting on the stream. Building commenced on July 19, 1802. President Jefferson gave Irenee his first order: refinement of some saltpeter. By 1811 the duPont mills were the largest on this side of the Atlantic.

Into Other Fields

The expansion of the United States after the War of 1812 brought much powder business to duPont. And a powdermaker duPont remained until 1902, when the company's management decided on research into fields far removed from explosives. And here's where the company's greatness first began.

A small band of chemists and engineers ranged over the entire chemical field, looking for new opportunities. Ample financial support was placed at their disposal. By 1906, $300,000 a year was going to duPont research—a huge sum for those days.

The studies made included research on artificial leather (Fabrikoid), lacquers (Duco), plastics and photographic film, synthetic fibers. Then came many other inventions.

The pinnacle of duPont success in the world of science and invention was probably reached during World War II, when this great company was asked to

help the development of atomic energy.

During the war, the company's "normal" progress and development had stopped. The laboratories limited their experiments almost exclusively to military projects. But post-war America had new needs and made new demands. To satisfy these, the company, after 1945, turned its attention.

The program included modernizing plants and adding manufacturing facilities to fill expanded markets for pre-war product lines. Nine new plants were built across the nation, and they are now supplying many of America's peacetime needs.

Side Trip

The student of genealogy will find much interest in the 138-page book. He can see for himself a vigorous family taking its place in the history of its company and its nation among those who do not shy away from grave management responsibilities.

It is a delight to analyze the faces of six generations of duPonts and to find in them, without exception, the character needed to guide a complex business through its many vicissitudes.

Rembrandt Peale, were he alive today, would find Lammot duPont as interesting a subject as Eleuthere Irenee.

While no doubt it doesn't belong there, we wish some mention could have been made of Winterthur, the fabulous 185-room home of Henry Francis du Pont, which is at present doing a most appreciated job of making America conscious of its traditions. It is Williamsburg, Virginia in capsule form.

These rooms have been filled with the accumulation of 300 years of American living, and have been made into a museum to which the public is being invited at $2 the admission. Appointments, as one can readily see, must be made months in advance. But the struggle's worth it!

Where the company will head is anybody's guess. It is now entering the 16th decade of its existence. No institution can long survive unless it earns and merits the public sanction that determines success or failure. duPont has had its measure of popular approval. On the basis of past performance, it looks as though it will survive to do much good for mankind!

CLEANER AIR WEEK NOTED NATIONALLY

CLEANER AIR WEEK, sponsored by the Air Pollution Control Association, was observed this year from October 20-26, and was promoted in cooperation with the United States Department of Commerce and many organizations actively interested in the problems involved in air pollution control.

The purpose of the observation is to promote a united educational program for cleaner air and to help build a better and a stronger America.

Charles N. Howison, Executive Secretary of the Smoke Abatement League of Hamilton County, Cincinnati, was national chairman, as he has been in the past three years, and he and his committee campaigned vigorously for cleaner air.

They sent special messages to mayors, governors, chambers of commerce, industrial leaders, professional associations, railroads, chemical, oil, and steel industries, civic leaders and service clubs, as well as to newspapers, trade publications, radio and television stations.

One of the best voluntary—and quite unexpected—promotions for Cleaner Air Week came from John M. von Bergen, Manager of Industrial Sales, Airkem, Inc., a member company.

Mr. von Bergen sent promotional material on the observance to all his distributors, urging them to participate on a local level.

"Our men," he said, "appreciate this opportunity to help in this excellent program, and I appreciate the opportunity to do the same."

LOS ANGELES HOLDS INSTITUTE ON AIR PURIFICATION

A MOST INTERESTING meeting was held in Los Angeles in connection with Cleaner Air Week on October 24. It was the first Institute on Atmospheric Purification, and was sponsored by the Manufacturing & Industries Committee, the Atmospheric Purification Committee, and the Scientific Committee of the Los Angeles Chamber of Commerce, as well as the Los Angeles Air Pollution Control District.

The speakers included George J. Murray, Jr., Director of Public Relations of the Tide Water Associated Oil Company, who, as general chairman, opened the meeting with a factual review of the problem of control of emission of industrial pollutants, and the progress made to date in effecting its solution.

Lawrence J. Grunder, of the Richfield Oil Company, spoke on *Highway Traffic Contributions to Air Pollution*, and Gordon P. Larson, Director of the Los Angeles County Air Pollution Control District, gave a report on the extent and area of research in the field of local air pollution and official actions taken or planned to reduce the emission of pollutants into the atmosphere.

Combustible Rubbish Disposal and Air Pollution was the subject of the discussion contributed by Warren A. Schneider, waste disposal engineer, Los Angeles, and A. M. Rawn, Chief Engineer and General Manager, Los Angeles County Sanitation Districts.

Andrew H. Rose, Jr., Head Engineer, Los Angeles County Air Pollution Control District, spoke on *Control Equipment for Industrial Pollutants*. After dinner L. M. K. Boelter, Dean of the College of Engineering, University of California at Los Angeles, spoke on *Climate, Geography, and Population in Relation to Air Pollution*.

Residences Excluded From Working Districts

THE CITY of Raleigh, N. C., according to the Municipal News, recently amended its zoning ordinance to exclude residences from industrial districts.

This change is in accord with present-day zoning theory, which is based on the facts that when residences are permitted in industrial districts (1) tracts necessary for industrial purposes are subdivided and rendered difficult to assemble, (2) the city is forced to provide schools and similar facilities in a patently unsuitable district, (3) inhabitants are inclined to harass industries with complaints about the normal noise, odor, dust, etc., associated with industrial operations, and (4) the area is unsuitable for healthy and pleasant living facilities.

SOME of the most disappointed people are those who get what is coming to them.

Is the Golden Rule also buried at Fort Knox?

Dirt - Filled City Air Isn't Necessary; A Great Deal Can Be Done About It

by WALTER C. McCRONE, *Senior Chemist*
Armour Research Foundation of Illinois Institute of Technology
Reprinted from the June, 1952 issue of the *Frontier*
Published by the Armour Research Foundation

AIR POLLUTION and other community nuisances are demanding more and more attention as our cities become more crowded and more industrialized. The feeling is widespread that sooty, smoky atmospheres are unnecessary and that with sufficient public clamor such conditions can be eliminated.

As a result, city, county and state agencies, as well as industry, have applied a great deal of research and engineering efforts to this problem. Cooperation between industry and local governments has already resulted in considerable improvement in air pollution in certain areas such as St. Louis, Pittsburgh, Columbus, Milwaukee and to a lesser extent in the larger cities such as Chicago and Los Angeles. At the same time, certain facts have become obvious as a result of these studies.

1. There is no single answer that will solve the air pollution problem for every locality. The nature of the pollutants as well as topographical and meteorological factors plays an important role. Los Angeles and Chicago, for example, have very little in common in any of these respects, and the air pollution problem in these two cities will have to be handled quite differently.

2. Air pollution in any city is not due, to any large extent, to industry, railroads or public utilities. These are usually concentrated sources of pollution which thereby attract attention, but their percentage contribution is small. The largest percentage contribution to air pollution comes from those who complain the loudest—the public. The thousands of small apartment and home furnaces in Chicago, for example, or the thousands of trash burners in Los Angeles and the millions of automobiles, trucks and buses in both cities contribute far more to air pollution than the total industry in those cities.

Controlling air pollution is, then, like voting; each of us can make only a small contribution, yet the final result depends on the sum total of our individual contributions.

Much more must be learned about the sources of pollution and the causes of pollution from each source in order to eliminate that source. Starts have been made in most large cities. Los Angeles is well on the way toward complete understanding of its problem through research sponsored by the County of Los Angeles and by the industries of that area.

No organized research has been carried out in the Chicago area as yet, although progress in decreasing smoke has been made through the efforts of the Chicago Department of Smoke Inspection and Abatement. There are however, indications that Chicago is becoming aware of the situation.

At a luncheon meeting of the Midwestern Air Pollution Prevention Association (MAPPA) May 15, Dr. Haldon A. Leedy, president of MAPPA and director of Armour Research Foundation, announced that the Board of Directors of MAPPA had approved a research program with an initial appropriation of $25,000 to study air pollution in the Chicago area. The money for this and future programs to decrease air pollution must come from industry and others interested, he said. Dr. Leedy requested support by membership and contributions to this program.

The broad program has three parts:

1. Statistical Survey of Factors Contributing to Smoke Violations

The City Department of Smoke Inspection and Abatement has in its files a large number of case histories on smoke violations. Each case history includes these factors:

Type of plant;
Type and size of firing equipment;
Type of fuel;
Smoke prevention equipment;
Operating condition;
Number of reports and violations.

Statistical studies of such data should lead to definite conclusions as to the factors responsible for smoke violations in Chicago.

2. Sources of Air Pollution

Additional work is necessary to characterize fly ash from all possible sources. The problem here is the collection of products of combustion from railroads, homes, power stations, internal combustion engines, etc. so that the particulate matter can be characterized as to source. Other components of dust, such as animal and plant fibers, pollen, plant seeds and soil are easily identified microscopically. This portion of the program will include sampling from specific stacks during definite burning operations fol-

Inversion over Chicago Loop district. Air currents are moving downward, keeping dirt in air layer close to ground.

lowed by microscopic and photomicrographic study of these samples.

3. Educational Program

This phase should be started as soon as results of the first and second phases become available. This would include newspaper publicity, writing of pamphlets and presentation of talks before interested groups.

Sources of Pollution

A great deal is already known about the nature of air pollution and its sources. The sources can be tabulated as follows:

1. Combustion products: Coal, gas, oil, wood, incinerators, backyard and alley burning of trash, internal combustion engines.
2. Dust and dirt: Soil, sand, products of rust and corrosion, products of decay, industrial dust (foundries, lime plants, etc.), fibrous material (cloth, paper plant debris).

We also know that smoke is due to one or more of the following factors:

1. Use of the wrong fuel. Actually there is no bad fuel if proper coal, proper equipment and careful firing are used. Under these conditions, there will be little or no smoke.

2. Inadequate equipment.

3. Bad firing habits. A good fuel (proper burning characteristics and size) can be burned easily without smoke or it can be burned to give smoke. An inferior fuel can be burned without smoke in good equipment by good firing practices. An inferior fuel can even be burned in inadequate equipment by a good fireman with a minimum of smoke. With the best equipment and fuel available, however, the result still depends on the ability and vigilance of the engineer handling the boiler. It is a safe assumption that at least one-half and probably three-quarters of the smoke produced in Chicago can be prevented.

What can be done to prevent smoke? Before answering this question, smoke may be defined as a mixture of particles made up of fly ash (which is completely burned coal ash), free carbon (which is partly burned coal) and tarry sticky hydrocarbons distilled out of the coal by heat but not burned. A dense black smoke will contain well over 50 percent unburned fuel, and in fact, under the conditions giving such a smoke you can be sending over one-quarter of your fuel up the stack unburned.

One of the keys to smoke prevention is complete combustion. Given plenty of air at a high temperature and an adequate mixture of air and fuel gases, your fuel will burn completely. With inadequate air, low temperatures or ineffective mixing of the air and fuel gases, smoke is inevitable.

This is the situation which we all know as smudge fires. To make a smudge fire with any fuel from coal to dry leaves all you have to do is cover the fire zone with cold fuel. This distills the sticky hydrocarbons out of the coal and carries them as unburned condensed black smoke up the stack.

Some coals contain a high percentage of tarry hydrocarbons and, like tar paper, are more difficult to burn without smoke. They can be burned without smoke, however, if adequate air is mixed with hot gases in the flame zone.

One of the most effective means of achieving the addition of secondary air, and at the same time improving the mixing of the hot gases, is through the use of over-fire jets. These jets, when properly designed and installed, cause turbulence in the flame zone thus mixing the gases and aiding burning. In some designs they may also create a baffle of air that prevents the smoke from passing directly out of the fire box unburned.

It is necessary, however, to be very careful in the use of forced air systems since this air has a cooling effect and also increases the velocity of the gases through the boiler. There is, for every boiler, an optimum amount of secondary air for best results.

Too little air will give unburned smoke; too much air will cool the gases too rapidly below the burning temperature. This will increase the velocity through the flues, boiler and breeching box and may carry heavy smoke up and out of the stack. The use of forced air by any means must, therefore, be carefully controlled.

Another aid in preventing smoke is to keep the damper into the breeching box open only enough to prevent blow-back into the boiler room. This cuts down the velocity of hot gases through the fire zone, boiler and breeching box and helps in two ways to prevent smoke. First, it gives more time for complete burning of the smoke, and, second, it allows time for the heavier particles at least to fall out of the gas stream into the settling chambers.

Keeping the dampers as nearly closed as possible is good general practice, but even more important it is very necessary when you are blowing tubes and flues. Blowing flues without smoke is an art, but an art made easier by cutting the gas velocity through the damper. It is better to blow often than to blow everything in the boiler out of the stack as smoke.

Another aid in preventing smoke during flue-blowing or fire cleaning operations is a stack spray. Such a spray is very easily installed in any stack and will not only scrub smoke out of the stack gases but will wet down the walls of the settling chamber and the material in the chamber. This prevents pickup of settled smoke into the stack during periods of high velocity.

Most of the above recommendations are written for firemen of industrial, school, hotel or large apartment house boilers. The same general ideas are also essentially correct, however, for small furnaces in homes, for incinerators or for that matter for any flame from a candle to a brush fire. If there is plenty of air mixed thoroughly in the hot fire zone there will be little or no unburned material and therefore little or no smoke.

The Midwestern Air Pollution Prevention Association has made an excellent start in the study of air pollution in Chicago. It deserves the support of all public-spirited citizens and industry in the fight against smoke and smell in the air we breathe.

LIME GRINDING IN IRELAND

LIMESTONE grinding plants are springing up all over Ireland. This method of supplying fertilizer has developed into a business with an estimated cash turnover of $3,000,000 a year.

Because limestone contains calcium, needed for animal feeding, the Ballybeg plant, in County Cork, has installed a tower for collecting fine air-borne lime, otherwise wasted.

Cloth Type Dust Filters Used in Industry

by F. A. EBELING, *General Sales Manager*
The W. W. Sly Manufacturing Co., Cleveland

ONE OF THE MANY sources of air pollution is the escape of dust from cutting, crushing, grinding, pulverizing, screening, mixing and packaging of many industrial products. When no attempt is made to suppress the dust arising from these and similar operations, it permeates not only the atmosphere near these operations but, because a large percentage of dust particles are in the low micron range of size, they will float for hours and spread over the neighborhood of the manufacturing plant.

A clean plant has so many obvious advantages that there is no need to dwell extensively on the many benefits derived from a practical dust suppression system.

There are many cases where the dust recovered by an effective unit is of value, and this alone may pay for the cost of the installation in a short time, and continue to make money for the owner over and above the cost of operating and maintaining the system.

There is the case where a company installed a dust collecting system which included a large cloth type filter. Over a ton of very fine dust per day was collected and created the problem of its disposal. The plant manager looked around for a possible sale of this dust. He found not one but many and in a short time the demand for this fine dust was such that the company installed equipment to make more of it. Now this dust has become a primary product of this company.

What a System Must Do

A dust collecting system must do three things:

1. Suppress the dust at its source
2. Collect the dust
3. Dispose of the collected dust

Suppression of the dust at the source is a science based on a few practical fundamentals, which, if applied properly, will do a good job economically. This article deals primarily with float dust. The flow of such dust can be controlled by rather slight air currents.

Realizing that the size and cost of a dust collecting system is in proportion to the volume of air which must be handled and filtered, it is obvious that the lower the air volume to accomplish the desired results, the lower the cost of the system.

On the average, floating dust can be made to flow in the right direction by an air current moving at the rate of 150 feet per minute (less than two miles per hour). Therefore, if a dust-creating machine is housed and the housing has, of necessity, openings having a total area of two square feet through which the dust would escape with no apparent force behind it, then an air current entering the housing through these two square feet of opening at the rate of flow of 150 feet per minute would mean an air volume of 300 cubic feet per minute.

If, because of considerable agitation within the machine housing, such as in an enclosed bucket elevator, or if dust is given momentum by a belt conveyor at 150 feet per minute, such agitation or motion must be counteracted by a corresponding increase in the rate of flow of the air used to draw dust into housing.

After so determining the necessary air volume to be drawn from one or more dust sources, the matter of determining the size of dust pipe is the next step.

Experience with thousands of dust control systems has taught us that the most dust in industry can be brought into suspension in the air within the entrance of a pipe by maintaining an entrance velocity of from 4,000 to 5,500 feet per minute. With some very light dusts a 3,500 foot entrance velocity is sufficient, whereas some very heavy dusts may require up to 6,000 feet.

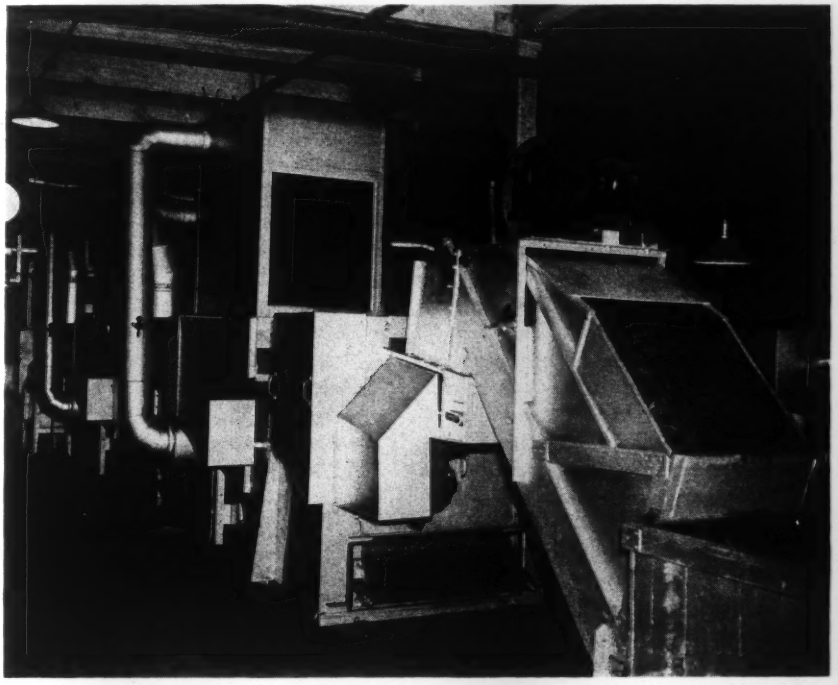
In the processing field there are many grinding mills which operate on the "closed circuit" system. These mills have fans which draw or blow the ground product into a separator. This separator discharges the product.

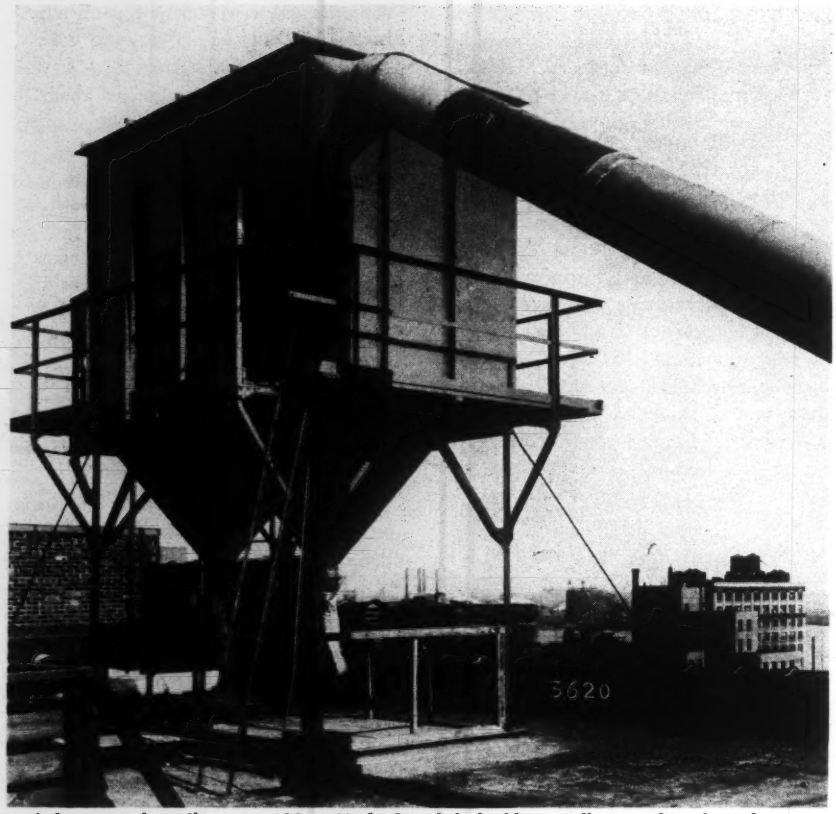
The air from the separator is returned to the mill fan. But air enters this system through the feed opening, and through leakage, and this additional air is released through a "breather."

Generally there is a rather heavy loading of dust in this air, and in many cases this dust, because of its fineness, is a product of greater value than that produced by the mill. A cloth type filter will collect and save this product.

Grinding operations generate heat, and sometimes, as in case of grinding clinker into cement, it is necessary to

Tobacco cleaning machines connected to bag-type filter located on building roof.





A bag-type dust filter on a New York City loft building, collecting dust from button-making machines.

keep the temperature in the mill below a certain point. Since cement must be of a predetermined fineness, the product from a ball mill is passed through a separator which separates out the product of the necessary fineness. The oversize "tailings" are returned to the feed end of the mill.

For cooling purposes, air at atmospheric temperature is drawn into the separator. This air will cool the material passing through the separator. The failings returned to the mill have been cooled and will correspondingly reduce the temperature in the mill.

The fines from the separator going to storage are also cooled. This cooling air leaves the separator and goes to a cloth filter. This air contains quite a volume of fine product which is also conveyed from the filter to storage.

The above are only a few examples of how dusts from industrial operations are suppressed at the source and are thereby prevented from entering the atmosphere of not only the plant but also the neighborhood of the plant.

Sometimes thought is given to reducing the dust content of a building by filtering all the air in a building. This would require a dust collector with fan and motor of very large capacity.

Take a building 100 ft. wide by 200 ft. long by 12 ft. high, a total of 240,000 cu. ft. Assuming an air change in thia building once every three minutes would mean a filter unit for 80,000 cu. ft. of air per minute.

But the air being filtered already has the dust in it and this dust will annoy the workmen and some of it is bound to settle on everything in the building.

And drawing this air from the building means the heating of 80,000 CFM every minute in cold weather. Compare this with a system which suppresses the dust "at the source." Assume that the dust comes from ten points which require a total of 10,000 CFM at these points to prevent the escape of the dust.

This then means the handling and filtering of only 1/8 of the air volume, with a filter and fan of 1/8 the size. And only 1/8 of the air needs heating in winter. In addition, there is no dust in the shop atmosphere, because it has been prevented from entering the shop.

The type of cloth used on ordinary jobs, with air at ambient temperature, is a cotton cloth, sateen weave with a thread count of 68 and 104 per inch. This cloth is arranged in a filter in the form of vertical tubes or flat bags. The flat bag type has the advantages of having more cloth per square foot of floor space, and of a more vigorous shaking action for periodic removal of the dust from the cloth. The flat bag type also permits easier inspection and accessibility to all parts from the dust chamber and clean air chamber. With a thread count of 68 and 104 per inch, a square foot of this cloth has over one million apertures between threads. Each of these openings is overlain by the cotton fibers which protrude from the threads. So the air passages through the cloth are so infinitely small, that dust particles of submicron size are readily retained. Therefore, a cloth type filter will collect practically 100% of even the finest commercial dust.

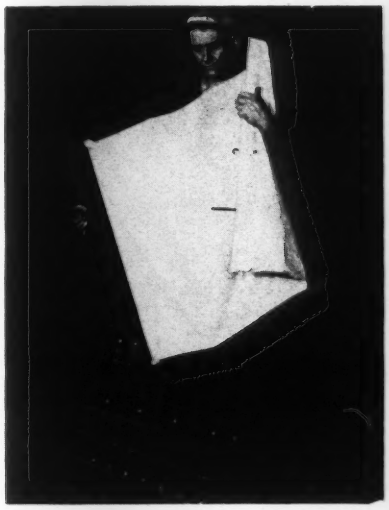
For temperatures over 180° F., up to 220° F., bags made of pure wool cloth are used. Because of the nature of wool threads, the dust retention quality of wool cloth does not quite come up to that of cotton cloth, but after wool bags have been in use for several hours, some of the fine dust will stay lodged in the cloth, and bring its performance up to very close to 100%.

For still higher temperatures synthetic fabrics such as Orlon are used. Glass cloth has been tried experimentally but its brittleness causes it to break and tear from the shaking action, requiring frequent costly replacement.

The bags in a cloth type filter must be cleaned intermittently. This is usually done by shaking the bags mechanically. This removes the greater part of the dust from the cloth surfaces, dropping the dust into the hoppers under the filter bags. During this shaking period no suction should be on the bags as otherwise the dust would be held on the cloth by the suction. This then, means that a dust filter must be shut down periodically. Generally this is done during lunch hour and at quitting time, or at about four hour intervals. The shaking of the bags is then controlled automatically, through

Clean air chamber with outlet to exhaust fan. Large chamber contains three tiers of filter bags. Bar grating over hoppers forms a walkway.

After unhooking, the bag can be pulled out into the clean-air chamber.



Spacers being removed from inside of bag.

a timer which is energized by opening the fan motor switch.

There are many industrial operations which are continuous, that is they cannot very well be interrupted for shaking the bags in a dust filter. In such cases a filter divided into two or more sections is used, each section with its own shaker motor. Periodically, generally about once an hour, each filter section is shut off by an automatic timer.

Recently there has been introduced another method of cleaning the filter bags without shutting the filter down. A filter has a dust chamber and a clean air chamber. Between these are the filter bags. During the operation, both chambers are under suction from the fan. There is a difference of around 3″ W. G. in the suction in these two chambers. On the average the lean air chamber of filter is under 7″ to 8″ suction, with from 4″ to 5″ in the dust chamber. A suction hood travels across the open ends of the filter bags. This hood has a flexible tube which permits admission of air from outside the filter. When this hood is opposite a filter bag, the suction in the dust chamber draws air through the bag in reverse direction. This reverse air removes the dust from that bag; as the suction hood travels back and forth, all the filter bags are cleaned at an average rate of once every three minutes.

The removal of the dust from the filter bags is of utmost importance for this reason: A dust filter installation has for its purpose the collection of dust by filtering it from air. This air flow is necessary to catch the dust at the sources and convey it to the filter. This air flow must be maintained, but this would not be possible if the filter bags were allowed to lose their ability to pass this air. Therefore it is necessary to periodically clean the bags either by shaking, or by reversing the air flow.

However, there are dusts which cannot be removed from the filter bags by these means. These are fibrous dusts of light weight. Examples are cotton lint from napping or other operations in cotton mills, cotton dust from linters (machines used for removing cotton fibers from cotton seed), cotton dust from metal buffing operations. Also these dusts cannot be handled through discharge openings in hoppers.

For the collection of these dusts, a filter has a large housing or settling chamber under it. The dust enters this chamber and a good deal of it settles in it. The air passes upward into the filter where the remaining dust is caught on the filter bags.

This dust will fill the spaces between the bags and will form a very loose batting which will not restrict the flow of air and therefore need not be removed.

After the spaces between the bags are filled, thus no more of the dust can enter these spaces, so from then on all dust will be collected in the settling chamber under the filter. Occasionally this chamber has to be cleaned out.

An interesting phase of a dust collecting system is the disposal of the collected dust. Most dusts, except dusts similar to cotton lint, lend themselves to collection in and disposal from hoppers.

Therefore, filters used for the collection of such dusts are equipped with hoppers. The collected dust may be discharged from these hoppers through manually operated gates into boxes, barrels, wheelbarrows, or trucks.

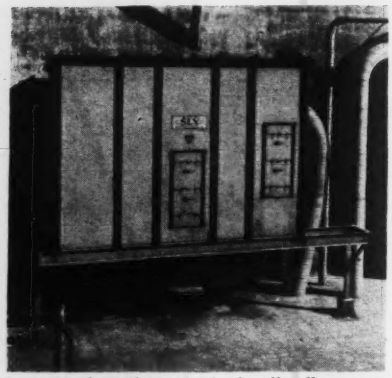
It may also be put into kegs or bags for sale. Many installations have continuous discharge valves which discharge the dust into a conveyor for return to the manufacturing process, or for conveying it to a single point of disposal.

The amount of dust collected and to be disposed of varies greatly, due to the size of an installation and the concentration of dust in the filtered air.

This concentration may vary from ½ to 10 grains of dust per cubic foot of air, with an occasional higher concentration. (A pound represents approximately 7000 grains.)

An installation handling 10,000 CFM with a dust loading of 3 grains per cubic foot would collect 30,000 grains of dust or about 4 lbs. per minute, or 240 lbs. per hour.

If this dust weighs 30 lbs. per cubic foot, a total of only 8 cu. ft. of dust would have to be handled per hour. Even



Bag-type dust filter in a feed mill collecting up to 1,500 lb. of valuable dust per day handling corn, barley, wheat, and rye.

a dust concentration four times as great would only mean 32 cu. ft. per hour, all well within the capacity of a rather small screw conveyor.

There is quite a fair percentage of industrial dusts which has a tendency to pack. Some poking may be necessary when discharging such dusts through manually-operated gates. Where continuous valves are used, they discharge the dust without letting it accumulate in the hoppers, and the valves are equipped with rappers for the side of the hoppers.

In extreme cases use is made of vertical partition plates in the center of the hoppers. The dust will not cling to these vertical plates. In one case the owner of a filter handling starch dust solved the problem of discharge by shellacking the inside of the hoppers.

In conclusion, we would like to point out the steps to be taken in arriving at the size and cost of a practical dust collecting system.

First, the air volume required should be determined. Due consideration must be given to temperature and moisture content of the air to be handled.

Then a filter should be picked on the basis of a reasonably low ratio between air volume and filter cloth area.

Then find a place, inside or outside, for this filter and its fan, considering the location of the dust sources and the disposal of the collected dust.

An average ratio is from 2 to 2½ cu. ft. of air per square foot of filter cloth. With expected high dust concentrations, go to a ratio of 2:1 or lower, also with dust which may be "sticky" or which tends to agglomerate. With light dusts which flow readily, a somewhat higher ratio may be used.

JAPANESE ARE SMOKE PREVENTION CONSCIOUS

High Cost of Fuel Given as Principal Reason

by HARRY DOBRIN, *President*
Furnace Engineers, Pittsburgh, Pa.

Extremely interesting to fumifugists was the trip taken to Japan recently by a Pittsburgh furnace engineer. He graciously consented to give some of his impressions to Air Repair—which are herewith passed on to our readers.

MY RECENT VISIT to Japan was primarily to see at firsthand some of our furnace installations, to see our Japanese agents, and to observe the various operations and the degree of progress being made by the steel industry in Japan.

There have been quite a number of Japanese in the last two or three years who have been visiting this country, and who have also visited our organization. They were very anxious to adopt some of the methods now being used here in the steel industry, especially with respect to the use of fuel and the application of heating furnaces of quality, uniformity and production capacity.

Eventually we sold them some furnaces furnishing them equipment and instruments which were not available in Japan, and also comprehensive drawings and bills of material so they could construct these furnaces in Japan, using as much material that they could provide themselves, such as, steel, structural members, as well as the refractories which they produce. These refractories I found, subsequently, are of very good quality equaling anything we produce in this country. They seem to have good native clays and do have a good deal of know-how in the making of good fire brick.

Our furnaces are somewhat complicated, although very simple in their actual operation. Nevertheless, there are certain features about these furnaces which require a good deal of technical knowledge in order to get results.

We have found from experience—and this especially was true in England, Holland, France, South Africa, and Belgium—that it is most essential to have one of our erecting superintendents to supervise the installation. This is especially true in cases where such furnaces have not yet been introduced.

In Japan, to our greatest surprise, they had erected the job themselves with their own labor and supervision, without calling upon our erecting superintendent to help them out.

When I first visited the Yawata Steel Works, they were operating exactly like those here in the United States that had the most careful supervision, servicing and starting.

When first arriving in Tokyo in company with one of the directors of our company, we soon noticed that this is a very large city and a very much crowded one. It may not be generally known that Tokyo has a population of over 7,000,000 and is among the five largest cities in the world. When visiting the offices of our agents and also some of the Tokyo offices of the steel companies, the number of people we saw working was rather suprising. Very few men, unless it be the top executives, have offices of their own. In one case, in a very crowded large office room, there were a great number of desks. Around one desk there was being held a meeting of the board of directors of the corporation.

Apparently, there is not very much heavy industry in Tokyo, but there are some steel works in the suburban sections of Tokyo. The main steel plants are in Osaka, Kobe, Hirohata and Yawata. Yawata has the largest steel company in Japan and produces practically every type of steel product that is being produced in this country, only on a much lesser scale.

The entire annual production of the steel industry in Japan is equivalent to what we produce here in the United States in from two and a half to three weeks.

Getting down to smoke. What is now called The Smoky City in Japan is Kobe, right across the bridge from Osaka. There are some five different steel plants in Kobe, and as you go across the bridge, you see heavy clouds of smoke streaming out of the different stacks.

Our Japanese representatives pointed out that there is a great deal of work to be done by the Japanese people to eliminate this smoke. This came to be the principal topic of the discussions we had with various managers and technical personnel of the five different plants whom we visited.

I told them that we had, at one time, the same problem here, and that this problem of smoke and air pollution has not yet been fully conquered in this country, but that it has been cleared up in many sections; Pittsburgh being one, St. Louis being another, etc., and that this battle is still going on here.

It appears that while the Japanese seem to have some very fine and ingenious technical talent in many phases of their industrial operations, they somehow have never seriously developed more high technical skill to be versatile in the art of combustion, fuel utilization and smoke prevention.

This is now one of the chief programs of the Japanese industrialists, because fuel is very scarce and costly. They are importing some coking coal from as far as Pennsylvania, and it costs them $28.00 per ton delivered in a steel plant in Japan. They fully realize that great economies could be effected by the careful utilization of fuel and by the proper use of the necessary instruments and controls which modern industry here in the United States has learned to adopt.

Most of us can recall the conditions that prevailed here in the United States, not only in the steel industry, but in many other industries, especially when fuel was cheap and it apparently did not seem to be necessary to do anything about fuel conservation.

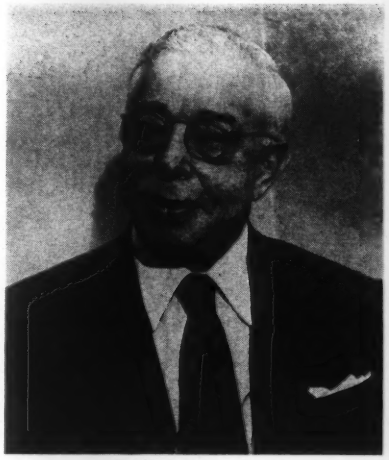
As far back as the 1920's, a very few engineers here had a technical knowledge of the conservation of fuel, the art of combustion and the use of insulating refractories or the use of instrumentation and combustion controls. Only here and there were there some organizations fuel-conscious enough to employ a fuel engineer, whose sole business it was to manage the application and utilization of fuels in the manufacture of steel or in the manufacture of many other products. At the present time, practically every steel company of any size uses a fuel and combustion engineer, who is surrounded by a considerable number of men who constitute a fuel department.

This is something that is now being seriously taken up by the Japanese, who were most eager to acquire some of the technical knowledge and skill needed to deal with this problem, and they are making good progress. We saw, for instance, in a plant at Hirohata, one of the most modern plate mills, second to none in this country or any other country.

The entire plant was built by a firm located here in Pittsburgh. Some firms disclosed to me their projected plans into the near future. They are planning definitely on American equipment, American technology, and American know-how for complete instrumentation, for proper temperature controls, and the proper use of proportioning combustion equipment to be sure that they are burning up all the fuel effectively. These plans do not only concern the use of fuel, but also relate to the use of modern machinery and mill equipment, almost duplicating operations such as prevail in the modern plants of the United States.

To be very realistic, there are any number of plants still in the United States who have done very little to modernize the use of fuel or the technology of their mills. We still have some very old mills which are obsolete, and there are still a great many fuel and furnace installations which operate and are being used the same as they were in the beginning of the century. Therefore, I was able to tell the Japanese industrialists that all installations in the United States are not up-to-date and that any number are as obsolete as many of those in Japan.

Japan has a population of 85,000,000 people, and is not any larger than the state of California, and they obviously must do their modernization within the acreage that they now have. Generally speaking, the treatment and respect with which we were received by the Japanese industrial leadership and their technical staff was something to be long remembered. We could see the eagerness of the young men to learn as much as possible. They put my associate and me



Harry Dobrin.

through the wringer in getting as much technical information as possible, which we generously gave them to the best of our ability, since we felt these people are really trying to follow the methods pursued by us.

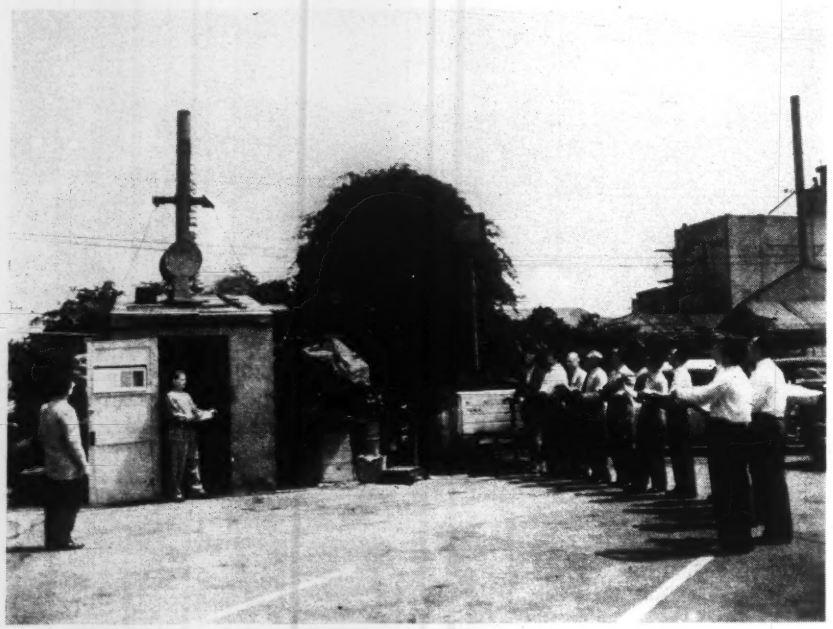
What may be of even greater interest to many people is that in preparing drawings and bills of material for the Japanese industries, we no longer have to use the metric system, because they now understand our system of yards and inches. They also use Fahrenheit for temperature index rather than Centigrade.

Now, disgressing somewhat back to the United States, I cannot help but mention a case here which prevailed in a steel plant at Mansfield, Ohio, where, up until recently, heavy clouds of smoke were issuing out of the stacks from the ingot heating soaking pits. These clouds of smoke almost served as an index to the airplane pilots who were flying over Mansfield.

By rebuilding these ingot heating soaking pit furnaces and introducing modern equipment, modern burners, modern instrumentation, combustion controls, etc., these clouds of smoke have disappeared entirely and it is almost necessary to have the pilots find a new landmark as to where Mansfield is. So the conclusion is that the battle against smoke and air pollution still has not been completely won here in the "good old U.S.A."

Effectiveness of Opacity Readings in Enforcing Control of Visible Emissions

by LLOYD H. McEWEN, *Chief Inspector*
Air Pollution Control District, County of Los Angeles



Los Angeles County Air Pollution Control District inspectors reading white smoke of 60 percent opacity. They attend periodic refresher courses in the observation and recording of visible emissions of all odors.

ENFORCEMENT OFFICERS charged with the responsibility of eliminating visible emissions from air-polluting sources in their respective communities will find that much can be accomplished with practical techniques which are not being utilized to their fullest.

The courts, as well as industry and enforcement officers, now accept the Ringelmann Chart as a means of measuring black smoke, despite technicalities involving stack diameters, reflected light, transmitted light, etc.

Even though the use of opacity readings now meets with these same objections, it has a potentiality which must be given serious consideration as a means of reducing pollution.

All visible emissions, regardless of their color, obscure the view of objects, dependent upon their ability to scatter and to obstruct the transmission of light. Such emissions, with the exception of water vapor, definitely add to atmospheric pollution and can be controlled.

Visible emissions which are created through the combustion of carbonaceous material are considered as smoke in Los Angeles. Visible emissions from other processes, although not considered as smoke, have a visibility obscuring power. They are observed and recorded in the same manner as are the products of combustion.

In this category are visible emissions from such sources as gray iron cupolas, steel furnaces and most other metallurgical industries, hot asphalt plants, asphalt roofing factories, coffee roasters, mineral processes, sand blasting operations, metal cleaning equipment, catalytic cracking units, etc. By properly reading and recording the opacities of these emissions, air pollution control officers can accomplish much toward compelling the reduction of emissions from such sources.

A photoelectric cell will indicate the same reading for a 60% obscuring white, gray or brown emission as it will for smoke of No. 3 Ringelmann. There should, therefore, be no confusion in judging visible emissions that are of colors other than black. Inspectors and engineers can be trained to read and accurately record all colors of visible emissions in percentage of opacity.

The Ringlemann Chart provides five distinct shadings of gray and is used as a guide in determining the density of black smoke.[1] Its practical use has been demonstrated for many years. Emissions of any color can be compared in their visual obscuring quality (opacity) with the various shades of smoke that are indicated on the Ringelmann Chart.

To use effectively opacity percentages of emissions that are other than black as a tool in enforcement, one has but to compare these opacities with the visibility obscuring value of black smoke.

Black smoke of No. 1 Ringelmann density obscures an observer's view by 20% and therefore has an opacity of 20%. Similarly, No. 2 Ringelmann black smoke has an opacity of 30%; No. 3 Ringelmann, 60%; No. 4 Ringelmann, 80% and No. 5 Ringelmann, 100%. An emission of any color which completely obscures an observer's view, obscures his view by 100% and therefore has an opacity of 100%.

By properly relating per cent opacities of all colors of emissions with the visibility obscuring value of Ringelmann black smoke, a very definite and practical means is available for judging the emissions from many sources.

In order to use effectively the Ringelmann Chart and opacity readings as enforcement tools, the inspector must, of course, be supported by an adequate law. Control laws, ordinances and codes must be worded in such a manner that the density of emissions of any color are included in their prohibitions.

The California law prohibits the emission of black smoke of No. 2 Ringelmann density or darker and visible emissions of any color of the same or greater opacity as has No. 2 Ringelmann smoke for periods greater than three minutes in any one hour. This definite and very workable prohibition reads:

> Section 24242. "A person shall not discharge into the atmosphere from any single source of emission whatsoever any air contaminant for a period or periods aggregating more than three minutes in any one hour which is:
> (a) As dark or darker in shade as that designated as No. 2 on the Rin-

[1] See Department of Interior, U. S. Bureau of Mines Information Circular No. 6888.

gelmann Chart, as published by the United States Bureau of Mines, or

(b) Of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in subsection (a) of this section."

Note particularly subsection (a). This subsection contains the means for combating the discharge of visible pollutants regardless of their color.

Through the use of these very effective tools of Ringelmann number and opacity, the Los Angeles County Air Pollution Control District has reduced smoke emissions in the county by 80 tons per day or 33% since 1948 and additional reductions are being made daily.

Although dust and fume emissions, which are not actually smoke, are governed by a strict allowable weight discharge to conform to local conditions, opacity observations have aided materially in bringing such problems to the attention of management and thus have facilitated control measures without extensive stack testing. Dust and fumes have been reduced 48 per cent since 1948.

Those who have worked with these very effective measures have found them most powerful in enforcing control. During the little more than four years of use in Los Angeles County, these measures have led to the correction of several thousand air pollution problems.

Although it has been necessary to take only about 5% of these problems to court, more than 250 legal actions have been sustained on the bases of the accurate observance and recording of emissions of all colors by inspectors and engineers of the District.

The courts have upheld the validity of opacity readings by trained men as a means for reliably judging the amounts of visible emissions and have rendered their decisions upon the basis of testimony and reports of the inspectors.

Where the need exists for reducing visible discharge, a practical technique is available in Ringelmann and opacity readings to afford a reliable evaluation of the discharge and bring about action, legal or otherwise, to effect an improvement.

NEW MINE SAFETY FILTERS

by J. J. WELCH
Ketchum, Macleod & Grove, Inc., Pittsburgh

DEVELOPED ORIGINALLY to remove radioactive contamination from air exhausted during atomic energy plant operations, a new type of air filter, called the Ultra-Aire Space Filter, has now been made available for general industrial, institutional and laboratory use by Mine Safety Appliances Company, Pittsburgh.

Called the Ultra-Aire Space Filter, each filter is reported to be tested against fine chemical smoke and is certified to be at least 99.95% efficient against particles as small as 0.3 micron (about 12/1,000-000th of an inch) in diameter. In practice, the filter removes particles as finely divided as tobacco smoke, particles of which range from .05 to .1 of a micron.

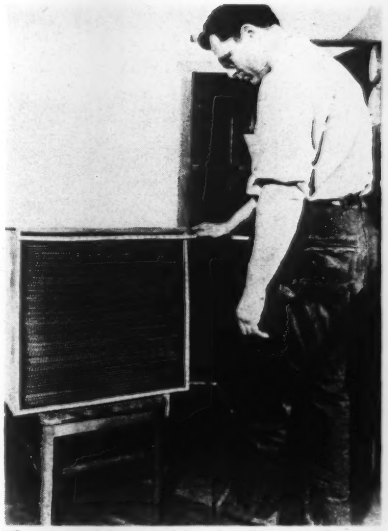
Simple in design and construction, the Ultra-Aire filter offers 46,000 square inches of filter media in the 1000 CFM size, and is available in air flow sizes of 50, 500 and 1000 CFM. Its effective service life, when protected by a roughing filter, is about a year and a half.

The new filter is said to have many applications where toxic and radioactive particles are a threat to health or production processes. In hospitals, it safeguards against bacteria and some virus when they are air-borne in operating rooms, isolation wards, and experimental laboratories. Producers of pharmaceuticals are told the filter prevents product contamination in processes where air conditioning is vital to manufacturing.

It can be made a part of an air conditioning system, either in the intake or exhaust.

The Ultra-Aire can eliminate radioactive contamination of photographic film and chemicals and is valuable to film manufacturers and processors. Placed in laboratory ventilation hoods, it safeguards workers in areas where toxic particulate matter is present.

Food processing plants can put the Ultra-Aire filter to work to trap spores which might cause spoilage and to eliminate bacterial contamination of food products. It can also be designed into bomb shelters to protect against radioactive airborne hazards.



This new Mine Safety Appliances filter can be used in laboratories, institutions, and industries to trap many kinds of air-borne particles.

Details on the Ultra-Aire Space Filter have been published in Bulletin No. CU-4, available from Mine Safety Appliances Company, Braddock, Thomas, and Meade Streets, Pittsburgh 8, Pa.

Ballman Conquers India

WHEN THE EDITOR of the weekly *Rajdhani*, leading journal of municipal and civic affairs in Delhi, India, saw the article entitled *Smoke Abatement, How It Started, What It Involves*, by Harry C. Ballman, Smoke Regulation Engineer, Columbus, O., he asked *The American City* for permission to reprint.

This permission was graciously granted, and Mr. Ballman's interesting article duly appeared—not only in English, but also in Arabic and Hindustani.

Rajdhani is principally concerned with municipal hygiene, its other subjects being health, exposed food, water works, building ordinances, mid-day refreshment for school children, purchasing problems, and governmental aid for communities.

Annual subscription to the magazine is six rupees. And if you only want one copy, the price is two annas.

N. A. P. E. APPROACH TO AIR POLLUTION IN LOUISVILLE, KY.

by HARRY LANE, *Secretary,* Kentucky No. 1 Chapter
National Association of Power Engineers
Presented at Meeting of East Central Section, APCA
Louisville, Ky., September 18-19, 1952

Harry Lane, an authority on fuel burning equipment, organized a Cincinnati engineering service in 1933. During World War II he served as field supervisor of the Iron Fireman Manufacturing Company, joining Dawson and Company, Louisville, as executive manager of the mechanical department in 1946.

A PERCEPTIBLE TREND towards deletion of the word *smoke* from organizational titles is of significant interest to members of the group that I represent. This trend indicates official and public recognition that *smoke* is but one of a multitude of contributing causes of air pollution.

The term *air pollution* signifies the inclusion of *all* air-borne contamination, and the word *control* denotes power of authority to regulate, check, or keep within limits the effluence of all pollutants. Prior to the immediate past, Mr. & Mrs. America were not conscious of existence of atmospheric pollution other than the visible concentration of minute carbon particles entrained in gas streams from industrial smoke stacks.

There is relatively recent public realization of wide-spread emanation of invisible toxic or noxious gases that are far more harmful to human life, plant life and to tangible properties than is smoke from burning of fuels.

It is not our intent to minimize the importance of regulation or control of excessive emission of smoke, dust, fly-ash, sulfuric laden gases, etc. that are resultant products of relatively incomplete combustion or poor firing practices which allow for improper release of the volatiles of solid fuels, and, in too many cases, from liquid or gasoline fuels.

It is our intent to advise this group of control officials, scientists, technicians and interested visitors that our engineering organization is sincerely interested in preservation of public health and advancement of community welfare, but we also believe in consideration of the economic stability of industrial and commercial enterprise.

The average urban householder should realize that he, too, is guilty of adding contaminants to the atmosphere. He should assume some of the responsibility for alleviation, rather than expect and demand that enforcement officials ban pollution by the simple expedient of closing industrial plants.

Our organization is actively engaged both physically and morally in attempting to control air pollution, and I propose herewith to outline the scope of operation of my associates.

A digression from the direct subject, however, appears appropriate at this point to allow us to clarify our position as participants in air pollution control and to attempt to erase a popular misconception as to *who we are* and to explain our objectives and reasons for the specific timing of our decision to assume the initiative in establishment of a new approach to solution of an old problem.

It was 65 years ago that the National Association of Power Engineers was organized and chartered by the "old time" stationary steam engineer, and while the present membership is composed of men of diversified titles, the common interest remains "economical production of power".

The objective of the Association is most simply exemplified by the creed "Education — Efficiency — Economy", and the organizational aim is betterment of the profession through education, by the medium of exchange of technical and practical know-how among members.

Among the 265 members of Louisville, Ky. No. 1 chapter there is existence of an immeasurable store of expert knowledge, probably because of the fact that our membership is composed of engineers of many classifications, including mechanical, electrical, chemical, combustion, safety, fuel, construction, design, supervisory, in addition to plant chiefs, operating engineers, maintenance engineers and mechanics and boiler operators.

That expert knowledge of proper fuel burning technique is an attribute common to the Power Engineer is undeniable, yet, since he is inherently smoke-conscious, there is existence of a question as to why our group failed to participate in some of the smoke abatement campaigns or crusades that have been waged intermittently since the discovery of coal as a fuel.

A simplified answer to this question is to call attention to the fact that these ventures were invariably inspired by very uninformed groups that usually attempted to establish and enforce regulations so unrealistic as to be unworkable.

We could not, either individually or collectively, lend assistance to movements so wishfully conceived but destined to be so ineffective because proponents of these campaigns were inclined to promote aggressive action without planned strategy.

The reason for their failures was due primarily to a lack of adequate knowledge of the implications of the air pollution problem. They failed to realize that in order to make a reasonably proper approach to air purification, there are many requisites, including:

A true conception of involvements of the problem. Realization that by the simple expedient of enactment of laws which in final analysis stipulate that "thou shalt not pollute the atmosphere" they cannot terminate the evil.

Public sentiment by aroused indignation must be tempered by educational methods and fore-warned of existence of a time element before expecting realization of an end result. A regard for the economical stability of the community as a whole, and with the realization that it requires money to maintain a properly

organized municipal, county or state pollution control board or commission.

Adoption of regulatory measures of permanent nature based on sound engineering principles, with wariness toward features tending to promote resistance because of unworkable aspects.

There is no alternative to retention of honest control officials, free of political or minority group pressure, and capable of administration of duties in a fair and equitable manner and with ability to obtain a maximum of cooperation with a minimum of police action.

When the city of Louisville lawmakers adopted an ordinance in 1946 and authorized revision in 1949, members of my association carefully analyzed pertinent detailed implications and concluded that there was existence of indicated intention to establish an air pollution control program that appeared to be of a permanent nature.

The rules and regulations, as set forth, were sufficiently flexible to allow for further revision to cope with air pollution regardless of its nature or source. After we had determined that the proposed program was fair and equitable to industry, business, suppliers of fuel and equipment as well as to men charged with conversion of fuel into useful work, we were very definitely interested.

Before establishing the precedent, however, of offering our services to industry and to control officials, we very carefully investigated qualifications and characters of the chief combustion engineer and his entire staff, since we were of the opinion that any appreciable progress toward containment of air contamination is dependent in no small measure on manner of enforcement and official concept as to the complex nature of the problem.

The very fact that our membership sanctioned appointment of a special smoke and air pollution control committee is conclusive evidence of our approval of Louisville control officials and of the basic design of a code of comprehensive inference.

The die was cast, and 25 members of the Louisville chapter, believing in a direct approach, proceeded to contact the city engineer, who gratefully accepted our offer to lend assistance to the best of our ability. This marked the start of a job that is recorded as highly successful, primarily because of a genuine spirit of cooperation between control officials and our group.

During the past year, our inspectors have visited approximately 30 plants that were considered among the worst violators, and records in Mr. Ralph Bourne's office indicate that improvments have been noted in most cases.

The committee's usual method of procedure is to obtain the names and addresses of violators that are recorded and on file for public inspection after citations are issued. We forward a form letter directly to management or owners of plants under fire. The text of this letter is as follows:

"Gentlemen—our special air pollution control committee, working in behalf of the Louisville Air Pollution Control Board, is interested in your smoke problem. You are hereby invited to take advantage of our offer to help you determine your course of action in eliminating excessive smoke emission, with a probable increase in your plant operating efficiency.

"Since we are a large non-profit educational organization of trained professional and practical operating engineers with a vast store of knowledge in fuel burning technique, we felt it a civic duty to offer our services to the city of Louisville and to the public.

"Through our efforts alone we know that many smoking stacks have been cleared and that the many owners who have followed our advice appreciate the fact that we have advised them in such manner as to enable them to alleviate their problem.

"This service was rendered by our association without charge to any plant owner. If you desire that we inspect your plant and consult with you as to conclusions we may determine, you may write directly to—"

After receipt of acceptance of our offer by owners or duly authorized representatives our chairman appoints two or more committeemen to make an inspection. They are instructed to obtain factual details relative to type and condition of fuel burning equipment, boilers and auxiliaries, note application of equipment and record physical dimensions of boilers, furnaces, stacks, etc. They observe operational procedures, note kind and preparation of fuel, minimum, maximum and average load conditions and extent of fluctuation of steam flow from boilers.

Efficient secretaries are hard to find these days. Helen Jaroski pleasantly surprised us when she took over the duties of Roberta Vetter. Get acquainted with Helen at Baltimore—she'll be at the registration desk!

Individual inspectors' impressions as to qualifications and willingness of personnel of boiler room and the degree of cooperation between production or process users of steam and power and boiler room help.

Reports of these plant inspections are presented for due consideration by the entire committee, acting as an advisory council, at a regular or specially called session, and after an open discussion to pin-point plant deficiencies and reasons why they exist, we proceed to attempt agreement on correctional methods.

With summarization of conclusions as determined by the council, the secretary is instructed to compose a letter to management of the specific plant, in which

he is advised as to our recommendations.

I believe that Air Pollution Control Association members will be interested in excerpts from some of the advisory letters we have written.

To one of our larger manufacturers we included these paragraphs:

"In view of our collective conclusions that the proper approach to assure of a continuity of steam flow at a minimum cost per pound would be the complete modernization of your plant, and with the realization that our scope of activities is necessarily limited to consideration of smoke elimination, we recommend retention of a reliable consulting engineer to draft plans and specifications for a more efficient plant.

"However, since this would necessarily take time, we urge that you take immediate steps to clear your stacks and avoid further smoke violations. This could be accomplished by installation of over-fire air, automatic regulation of draft and closer boiler room engineering supervision."

To another manufacturing plant manager, we advised in part:

"While our primary iterest is to advise methods of alleviation of smoke, it would be a display of unforgivable dis-service if we failed to point out plant and operational deficiencies that are so obvious to us and of such vital importance to you, since we can see that your direct losses at this time are at the rate of many thousands of dollars annually. We believe that the basic design of your plant should allow for smokeless operation, however, unless some auxiliary equipment is installed, you cannot hope to eliminate excessive smoke emission without curtailment of production."

We advised a hospital superintendent:

"It would appear that either of your brick set HRT boilers are of sufficient capacity to handle a summer load and that together they should carry a peak winter load. Design of the settings and stokers should allow for smokeless combustion.

"However, we advise that you make repairs to the breechings and to the furnace refractories. Your firebox type boiler and stoker appears to be responsible for most of your smoke problem, and this condition is caused by "off" and "on" type of operation. This can be corrected by installation of combustion controls which will allow for continuous operation and for proper fuel-air ratio."

A food processing plant was in serious trouble with our control office, and after our inspection we were in position to offer advice that plant management found expedient to follow and their expression of gratitude for our assistance tends to inspire my associates to desire to continue their good work.

Included in our letter of recommendation was the following:

"It is our understanding that you anticipate a complete modernization of your power plant and we heartily concur in this plan, however, we believe that unless this work is started immediately, you will have no alternative except to improve your present equipment and install certain auxiliaries to assure that smoke violations can be curbed.

"Since projected grate areas are so restricted as to allow for excessive burning rates and since furnace volume is proportionately restricted and allows for excessive heat release, we would suggest that extension of grate lengths by approximately 18 inches is one method of increasing grate surface, and since this would involve moving of bridge walls, there would be a direct increase in furnace volume.

"We feel that properly located jets for introduction of secondary air steam-air or preferably by high pressure blower fans would provide turbulence and add oxygen that appears to be deficient. We also urge that you install dependable uptake damper regulators as we note that your operators do not nor could not properly adjust draft to compensate for variable conditions.

"It was noted that your coal storage is exposed to weather, and since your stokers are of such design that excessive moisture on the fuel causes uniform feeding difficulties, we suggest covering all or part of the coal.

"A major problem that exists at your plant is the apparent inability of your equipment to properly cope with the unusually wide differential in steam demand which causes a smoke condition when load is suddenly dropped from absolute peak to minimum or when the cycle is reversed.

"It would appear that the possible answer is to arrange a system whereby load could remain reasonably constant, or, if this were impractical, there would be a signal arrangement between process workers and boiler operators to allow time for adjustments before radical fluctuations occur."

I sincerely hope that I have suceeded in presenting this paper in such manner as to be sufficiently explicit without accentuation of technicalities, for it is our belief that this proficient technical group would be most interested in the practical aspects of our work and methods of application of sound engineering principles or the proving or disproving of theoretical presumptives.

A few informative facts relative to our particular type approach to the air pollution problem are contained in paragraphs we read from letters to industrial management, in which we believe there is implied evidence that we attempt to be honest in our convictions and believe in proper placement of responsibility when smoke violations occur.

We have recorded just a few causes and some reasons for commercial and industrial smoke violations. While they represent a very small minority, we have found owners who assume an attitude of gross indifference toward smoke control and toward good neighbor relations. In numerous other cases, owners consider boiler rooms as necessary evils and are reluctant to spend money to abate smoke.

It is interesting to note that many "converts" have found that expenditures in the boiler room will in some cases develop into good sound business investments with assured returns equaling or exceeding profit margins on gilt-edge stocks or bonds.

There are, I believe, a few real hardship cases, where it is found economically impossible for owners to properly rebuild an obsolete or out-grown plant, but, we know that we can invariably prescribe inexpensive methods of alleviating smoke conditions to some acceptable degree, therefore, we do not believe in complete exemption of any specific plant.

The over-loading of boilers and stokers and sharp turn-down of steam demand accounts for many persistent violations. This type problem is most difficult, because inplant conditions are so variable that there is no standard procedure to follow.

Failure to design plants of sufficient capacities and capabilities to handle low

grade fuels of the territory, even though high grade fuel is considered most desirable at time of installation, accounts for existence of many "smokers", because of unavailability or increased cost of better fuels at an unforseen time.

Improper supervision of plant personnel and indifferent attitudes of engineers and boiler operators are responsible for issuance of many citations. This is a management problem that could well be rectified if dual responsibility for violations is a mandatory part of a control program.

Unfair complaints of neighbors that a specific plant is guilty of pollution in the form of dust and fly-ash emission that have later been proven groundless together with failure of municipal or other governmental agencies to maintain smokeless plants, is a basis for certain types of individuals to claim justification for non-compliance on grounds of discriminatory legislation.

One of our members recently made a statement that we could very well use as a closing paragraph since I believe it reflects opinions of our entire group. This statement was:

"Altho we have been instrumental in aiding in abatement of many smoke problems, we have done nothing more constructive than to create an improved relationship between appointed enforcement officials and with the public in general and large scale consumers of fuel in particular."

In conclusion, gentlemen, we believe that the city of Louisville has a good comprehensive air pollution control program and we further believe that our citizens are most fortunate in having men like Mr. Ralph Bourne and his very able staff as administrators.

Nelson W. Hartz, Instruments Line Manager of the Mine Safety Appliances Company, served as a major during World War II in the air force. Mr. Hartz is a member of the Instrument Society of America, American Society of Safety Engineers, and the American Petroleum Institute. He is the author of numerous papers on the subject of instruments for the detection of toxic and explosive gases.

INSTRUMENTATION IN AIR POLLUTION

by NELSON W. HARTZ
Mine Safety Appliances Company, Pittsburgh

IN THE LAST ISSUE of this publication there appeared an article by Dr. R. A. Kehoe elucidating the "Health Aspects of Air Pollution" which may yet be proven to be of far greater concern than are the nuisance or economic aspects of the problem.

In his paper, Dr. Kehoe made very clear his point that considerably more data must be collected and correlated to ascertain the effects of air pollution on the exposed population.

There is good reason to believe that long-term exposure to minute concentrations of certain contaminants in the air may by themselves have a significant physiological effect on large numbers of people or probably at least contribute to the deterioration of health of persons who have previously acquired certain diseases.

It appears that the correlation of these exposures with physiological response data will require years of study. In the meantime, the air pollution engineer must continue to determine the nature and extent of atmospheric pollution upon which these studies can be based and which in the future may prove to be important in diagnosing ill health in certain elements of the population.

This then means that studies made today should be directed so as to obtain all possible data about the nature and concentration of all of the contaminants of the atmosphere which on the basis of present knowledge may be physiologically significant. If the best techniques are used and skillfully applied, and the results and methods well described in records, then such data will be of value in future studies when efforts are made to relate past exposure to current population health.

Let us assume that some day medical research will prove that continuous exposure to a concentration of the order of ½ part per million of hydrogen sulfide will have a deleterious effect upon the population. How many of the studies being made today would be of value on that future date in appraising the con-

DON'T SAY IT, LADY — WE'LL SAY IT FOR YOU ... THERE OUGHTA BE A LAW!
Thanks to RUDOLF GOLLATZ, 239 S. FRONT ST., COPLAY, PA.
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McCLURE NEWSPAPER SYNDICATE

ditions that had existed in the communities who now subscribe to the ideas of monitoring and trying to improve their atmospheric conditions?

Anticipating that the studies being made today are but the feeble strides of an infant science, is it not reasonable to accumulate our data in the most specific scientific manner possible, with the results of all analyses expressed in specific finite values?

Today there appears to be a tendency to assess atmospheric pollution by relative means, such as filter paper stains appraised either visually or photo-electrically, or to rely upon the accumulation in fall jars. Surely such data is helpful in appraising the nuisance value of the problem and in reducing obvious dirt in the atmosphere, but it is very questionable whether these are providing the kind of data that will be useful for the long range problem of appraising the health hazards which we are creating in the atmosphere and our efforts to cope with them.

Data relative to gaseous contaminants in the air are generally expressed in specific values because the analytical procedures that have been established are quantitative. Dust analyses have been far less specific since one must consider not only quantity and composition, but also particle sizes. While methods such as the electrostatic sampler, thermal precipitator, cascade impactor, and impinger are useful in collection of spot samples, none of these lend themselves to continuously monitoring the atmosphere.

We must yet develop the ideal instrument for measuring aerosols in the atmosphere. Such an instrument should be capable of recording its data continuously or at least at frequent intervals. These data should have some finite quantitation such as milligrams per cubic foot, and the sample should be collected in such a fashion as to be available for chemical analysis and particle size classification so that the test results may be correlated with their effects upon man.

The instrument should be small enough to be transportable to alternate field testing sites, and once set up it should require substantially no maintenance except the normal replacement of charts and the removal of the collected sample.

It should be operable from readily available power sources. When such an instrument becomes commercially available, it should be possible for the air pollution engineer to accumulate tremendously more data than is now available, and it should be in such a form as to be of considerably more value for long range studies than the data that has been tabulated in the past.

Of course, such an instrument will strain the budget of the public bureaus who are charged with guiding the control and improvement of the urban and suburban atmosphere. There will be the temptation to use the present methods which are effective in eliminating the conspicuous components that are the basis of the usual housewife's complaint about dirty air. If we recognize that air pollution is a health problem that will be of continuing concern to a society that is committed to technological progress, then the tools of the air pollution engineer must be improved to keep him abreast of the problem.

Boulware to Address Industrial Hygiene Meeting

Lemuel C. Boulware, Vice President in Charge of Public Relations, General Electric Corporation, will be the keynote speaker at the annual meeting of Industrial Hygiene Foundation in Mellon Institute on Nov. 20.

Lemuel C. Boulware, General Electric Corporation vice president who will be the keynote speaker at the Industrial Hygiene Foundation's annual meeting this November, made news on many fronts during his impressive career. In a surprise move in June, 1947, he was charged with carrying out a new G. E. concept—that of bringing out new models in jobs, then selling those jobs to employees, as G. E. had been successful in continually getting out improved models of turbines, transformers, and toasters. He discharged the obligation with distinction.

His name is being added to the list of impressive leaders who have appeared before this meeting during the past 10 years. They include Manpower Commissioner Paul V. McNutt, General Motors' Vice Presidents Charles F. Kettering and Marvin E. Coyle, H. G. Batcheller, Chairman of the Allegheny Ludlum Steel Corporation and former Vice Chairman of the War Production Board, William B. Given, Jr., President of the American Brake Shoe Company, and D. G. Mitchell, President of the Sylvania Electric Products, Inc.

Dr. C. Richard Walmer, Managing Director of Industrial Hygiene Foundation, has been an enthusiastic supporter of APCA ever since its revitalization. He received his doctor's degree from the University of Pittsburgh and served as consulting toxicologist to Westinghouse Electric Corporation for five years upon completion of his residency at Mercy Hospital. He is a member of many distinguished medical and professional societies and is noted for his contributions to medical literature on the conservation of manpower and studies in industrial hygiene.

When Industrial Hygiene Foundation came into existence 17 years ago, it was primarily concerned with the problems of silicosis, of which 20 founding companies asked it to make a study.

So successful was the Foundation in this undertaking that other companies asked to join in order to benefit from the research it was carrying on. Today there are 365 companies, plus various governmental agencies, plus individual and special members in Industrial Hygiene Foundation.

Commenting on this growth, Andrew Fletcher, President of the St. Joseph Lead Company and Chairman of the Board of Trustees of Industrial Hygiene Foundation, said:

"It is solely because American industry has realized that one of the most important phases of efficient production is the well-being of its workers, and that through membership in the Foundation a company can obtain constructive advice and help.

"The Foundation is interested in training men to handle industrial hygiene problems, in setting standards, in outlining healthful procedures.

"The Foundation has been retained by the city of New Haven to conduct an air pollution study. It is conceivable that the findings can be utilized by other cities in solving pollution problems."

Dr. C. Richard Walmer, Managing Director of the Foundation, is a member of APCA, as well as W. C. L. Hemeon, Director of Engineering, who writes the column *Point of View* on page 60.

COAL PRODUCERS' COMMITTEE— WHAT IT IS AND WHAT IT'S DONE

Those readers who are unfamiliar with the Coal Producers' Committee for Smoke Abatement and its work over the past 11 years will read the following condensation with interest. It is taken from the address given by H. B. Lammers, Chairman and Director of Engineering, Coal Producers' Committee for Smoke Abatement, Cincinnati, O. It was presented at the ninth semi-annual meeting of the East Central Section of the Air Pollution Control Association, Louisville, Ky., on Sept. 18, 1952.

THE ORIGINAL sponsors of the Coal Producers' Committee for Smoke Abatement were a far-seeing group of progressive producers and shippers of bituminous coals.

These coals have a wide range of analytical values, burning characteristics and a multitude of uses: domestic, commercial, and industrial heating, process and power with many suited for chemical and metallurgical requirements.

Competitors with oil, gas, and low volatile coals to sell, featured the "smokeless" operation of their products and were prone to attribute all smoke, dirt and much ill health to the use of bituminous coals. This made it necessary for bituminous producers to improve the performance of their coals where criticism was justified, instruct users and the public generally in the proper and efficient utilization of the coals.

Moreover, the sponsors of the Coal Producers Committee for Smoke Abatement knew that many millions of tons of their coal were being burned without creating air pollution nuisances.

They therefore believed, and rightly so, that the same results could be obtained with 100 percent of their products; if an engineering service organization was put to the task of working for shippers and public alike wherever and whenever emissions from bituminous coal burning were a factor in a community's air pollution problem. They succeeded in effecting such an organization in 1941.

Among the Committee's many activities are included:

Surveys

Surveys have been made in individual plants, cities, metropolitan areas. In most cases it was the first, and in many, the only real appraisal a city every received of its problem.

Surveys have disclosed the sources of the problem and for the coal industry many answers have been found. Surveys also disclose that air pollution in our cities comes primarily from our industrial civilization and encompasses all fuels and processes.

Education

Education on matters of air pollution, contrary to belief, does not start in the boiler room, although operational instructions have been prepared and widely distributed.

Education begins at the management level, be it civic, industrial, or political. It has long since been demonstrated that "an ordinance" is not the complete answer to the problem.

Lectures have been presented outlining the problem and its solution to civic, educational and engineering groups. Rules and regulations have been prepared pertaining to the proper installation of fuel burning equipment to effect a reduction in air pollution. A technical library has been established and is available as a reference center.

Engineering Service

This type of service has been provided for individual plant owners, associations of manufacturers, chambers of commerce, municipalities, sponsor associations, equipment manufacturers, boards of education, smoke departments and other public groups.

Cooperative Activities

This includes work with National Coal Association, Bituminous Coal Institute, Stoker Manufacturers Association, retail dealers associations, Class 1 railroads, health departments, ASME, NAPE, GLAPAP and many citizens' groups.

Research and Technical Activities

This includes participation on various Bituminous Coal Research Committees on fuel and equipment research; committee on air pollution of the ASME.

The overall result of all these activities has been that everyone concerned with air pollution in the Committee's working area has a better appreciation of the problem now than previously. The coal industry certainly understands the problems better than it did 10 years ago.

It now knows that all air pollution certainly does not originate with coal; that much of the problem is associated with the design, application and installation of the fuel burning equipment as well as its proper operation. It also recognizes that much more of the general problem of air pollution exists because of economic and political considerations difficult to control.

Future Plans

The problem of air pollution from fuel burning will be with us for a long time since it concerns itself with installation application, maintenance and operation. The human element is so important, that the matter of continued education becomes a prime essential and No. 1 on the list of plans for the future.

1. Education.
2. Surveys in additional cities.
3. Plant inspections to demonstrate to owners economy and efficiency of new equipment and/or modification.
4. Correct application of equipment and fuel utilization.
5. Improved performance of lake vessels.

6. Application of overfire jets to existing equipment; auxiliaries as required on others.
7. Small steam plant betterment programs.
8. Reappraisals (for further reduction in emissions) of programs where base values have already been established and on record.
9. Continued cooperation of Committee and various smoke departments on difficult problems.

MALLETTE TAKES NEW POSITION

Frederick S. Mallette, formerly assistant director of research in charge of air pollution control activities of the American Steel and Wire Division of the United States Steel Company, Cleveland, O., has been named executive secretary of the Committee on Air Pollution Controls of the ASME, according to Thomas E. Purcell, Duquesne Light Company, Pittsburgh, chairman of the committee.

Mr. Mallette has had more than 15 years' experience in the engineering, health, and legal phases of atmospheric pollution problems, and he is widely acquainted with the many organizations working in this field.

His first venture into air pollution consisted of making special studies under the late Harry Meller, who headed the air hygiene fellowship at Mellon Institute, which later became the Industrial Hygiene Foundation (see Page 46). During World War II Mr. Mallette served on an ASTM War Standards Committee, receiving an award for his work from the government.

"Mr. Mallette's appointment," Mr. Purcell pointed out, "marks another step forward in ASME's continued alertness on problems of interest to its members. The Society con now look forward to seeing its plans for participation in the important matter of air pollution control progress effectively."

The ASME has long recognized the problems of both the public and industry in the field of atmospheric pollution. For many years it supported a committee which studied the problem of air pollution as effected by smoke and dust, and in 1949 the Society made a valuable contribution to the field of smoke abatement when the Smoke Law Committee of the

Frederick S. Mallette.

Fuels Division prepared and published *Example Sections for a Smoke Control Ordinance,* which set forth standards of emission of smoke and dust from industrial processes.

These standards, being based on sound engineering principles and economic possibilities, have been very widely accepted both by industry and by official agencies.

Recognizing the need for technical guidance, the Special Committee recommended the formation of a Committee on Air Pollution Controls composed of representatives from the many organizations having substantial interest in this field. As a result, some 24 representatives met for an organization meeting on Nov. 29, 1949.

Immediately this group appointed subcommittees to review representation and to define a scope and a plan for the main committee. Realizing that smaller groups are more effective, a Steering Committee was recommended. Then the directing group met to discuss the proposed objectives which are, in part but not exclusively, to initiate and coordinate research concerning health, comfort, nuisance, engineering, and economic aspects of the problem, to collaborate in the formulation and publication of standards of appropriate nature, to encourage and assist in the preparation, presentation, and publication of papers on the many phases of atmospheric pollution. The seven-point program to implement the objectives consists of:

a) Sponsoring the preparation and publication of a historical summary of the air pollution problem.

b) Providing a clearing house for information on control projects and trends among manufacturers and public agencies.

c) Defining accepted economic and public health requirements for the abatement of nuisances or troublesome emissions.

d) Encouraging the preparation of economic analyses to measure efficiencies of various degrees of pollution abatement and the effect on the community or adjacent industry.

e) Fostering the study of fuel use of all types, the actual emissions of different equipment, and the efficient use of all fuels in the best equipment.

f) Stimulating research for the definition of upper limits of emission as influenced by meteorology, and stack discharge location.

g) Developing and codifying specific approximate and visual measurements of contamination and density of emission.

To carry out this ambitious program a series of subcommittees have been appointed:

1. Subcommittee on Health and Industrial Requirements. Chairman, J. F. Barkley.
2. Subcommittee on Current Projects and Trends. Chairman, H. B. Lammers.
3. Subcommittee on Economics of Air Pollution Control. Chairman, G. V. Williamson.
4. Subcommittee on Fuels and Fuel Burning Equipment. Chairman, C. E. Miller.
5. Subcommittee on Coordination and Promotion of Research. Chairman, H. P. Munger.
6. Subcommittee on Instruments and Measurements. Chairman, M. D. Engle.

Subcommittee No. 2 should be of particular interest to members of APCA. It will act as a clearing house for information concerning current projects and trends of controls by manufacturers and public officials. The information thus obtained may be published as a pamphlet of loose leaf sheets, to be revised as necessary.

By collecting information on past, present, and proposed projects from known sources and expanding the number of known sources by soliciting information from technical committees and

research men, a useful reference center can be set up which will be used because it is useful.

There is need for coordination, for many organizations are at work on different phases of the problem. To date the subcommittee has prepared and forwarded questionnaires to various groups, including smoke and air pollution control officials. Data from the questionnaires is being tabulated and a reference library is in the process of being established.

"The work of the committe is well under way," said Chairman Lammers in a recent letter. "Much interest has been manifested as evidenced by the speed with which the questionnaires were returned."

The members of this committee include, besides Mr. Lammers, C. A. Gosline, E. I. duPont de Nemours & Company; Mr. Mallette; Dr. Louis C. McCabe, Chief, Fuels and Explosives Division, U. S. Bureau of Mines; W. A. Schmidt, President, Western Precipitation Corporation; A. C. Stern, Division of Industrial Hygiene and Safety Standards, State of New York.

AIR POLLUTION CONTROL IN OREGON

by CARL E. GREEN

COMPARED to most states, Oregon is relatively sparsely settled and not yet highly industrialized. Its principal industrial development rests upon timber and lumber products. From the summits of the Cascade Mountain range to the Pacific Ocean large forested areas still exist. Fir, hemlock, spruce and cedar trees predominate in the western half of the State. East of the Cascade Mountains, the country is semi-arid to arid and the predominating trees of the forest are various species of pine, primarily Ponderosa. Because of the extensive forests, Oregon's lumber industry has long been foremost in the economy of the region.

Agriculture, tourist business and fisheries are also important in the area's economy. Situated in the center of the greatest present and potential hydroelectric development of the entire nation, Oregon, as well as other states in the Pacific Northwest, is destined to expand greatly in population and industrial development. The past twelve years have witnessed a phenomenal growth of population, the entry of heavy metals production and fabrication, chemical industries, etc.

Industrial growth and development are inevitably accompanied by problems of water supply, liquid waste disposal and discharge of gases and particulate matter into the air. All affect the economy, natural resources, well-being, health and living conditions of the people of the areas in which the development occurs.

Water Authority Established

In 1939 Oregon established a Sanitary Authority for the purpose of reducing and preventing the pollution of the waters of the State by sewage, industrial wastes and other deleterious substances. The objective was the prevention as well as the reduction of water pollution. A long term, sensible program has had public support and the results are gratifying.

Recognizing the increasing problems of air pollution and the need for control and prevention rather than correction after great damage might be done to property values, resources and public health, Oregon embarked upon what is believed to be the first state-wide control program of its kind in the United States.

Statewide Control Program

The legislation upon which the program is based is patterned in a general way after the successful water pollution control act. Fluorides from aluminum production plants and gases from pulp and paper mills in certain sections of the State spurred interest in the problem.

The serious consequences of air pollution in other places such as Donora, Pa., and Los Angeles, California, served to emphasize the importance of preventive rather than corrective work. Continued development of hydroelectric power in the Columbia River basin and the planned entry of natural gas both will accelerate industrial expansion and diversification.

These are the men among those responsible for the air purification progress made in Oregon. Left to right: Richard E. Hatchard, Sanitary Engineer, Carl E. Green, Chairman of the Oregon Air Pollution Control Authority, and Curtiss M. Everts, Jr., State Sanitary Engineer, Secretary of the Authority.

Oregon's Governor Douglas McKay in April, 1950 appointed a committee to study the air pollution problem and prepare legislation. The committee charged with this work included representatives of the State Board of Health, State Sanitary Authority, State Department of Agriculture, Oregon State College, League of Oregon Cities and Industries. Advice and suggestions were received and considered from other interested groups: Association of County Officials, State Farm Bureau, State Grange, Farmers' Union and Portland Chamber of Commerce. Even before the activity on a state level, the Air Pollution Committee of the City of Portland had been working on the problem and preparing legislation for consideration by the City Council of Portland.

The Governor in his address to the legislature in January, 1951 recommended the adoption of appropriate air pollution control legislation. After hearing revisions and compromises with groups having different points of view and interests, the legislature passed and the Governor signed an act establishing the Air Pollution Authority and providing an appropriation to carry out the provisions of the act. The law became effective in August, 1951.

Provisions of the Oregon Air Pollution Law

The law provides for an Air Pollution Authority composed of five members, one of whom is the State Health Officer, one member of the State Sanitary Authority, and three others appointed by the Governor from the state as a whole. The State Sanitary Engineer serves as Secretary. The Authority members are:

Dr. Harold Erickson,
State Health Officer
Carl E. Green, Chairman
Consulting Engineer, Portland
Oren L. King, Vice Chairman
City Manager, Eugene
Merle West, Retired Lumber Executive, Klamath Falls
Harold Wendel, Business Executive, Portland

The Secretary is Curtiss M. Everts, Jr., State Sanitary Engineer, and the head of the personnel conducting the work under the Authority is Richard E. Hatchard, Sanitary Engineer.

Carl E. Green, the author of this article, has had a distinguished record in sanitary engineering. He is at present chairman of both the Oregon Air Pollution Control Authority and the Portland Air Pollution Control Commission. He was graduated from Stanford University with distinction, and served the state of Oregon as sanitary engineer for 13 years. He is a member of many professional societies and conducts a consulting and engineering practice.

The Act authorizes the Authority to carry on the following activities:

1. Develop a comprehensive program for the prevention and control of all sources of pollution of the air of the state.
2. Advise, consult and cooperate with other agencies of the state, political subdivisions, industries, other states, the federal government and with affected groups, in furtherance of the purpose of the Act.
3. Encourage and conduct studies, investigations and research relating to air pollution and its causes, prevention, control and abatement, as it may deem advisable and necessary.
4. Collect and disseminate information relating to air pollution, its prevention and control.
5. Promulgate rules and regulations.
6. Consider complaints, make investigations and hold hearings.
7. Require any person to submit plans for the removal of air contaminants.
8. Encourage voluntary cooperation by the people, municipalities, counties, industries and others in restoring and preserving the purity of air within the state.
9. Employ personnel, including specialists and consultants, purchase materials and supplies, and to enter into contracts necessary to carry out the purpose of this act.
10. For the purpose of investigating conditions relating to air pollution, the members of the Authority, or its duly authorized representatives, shall have the power to enter at reasonable times upon any private or public property except private dwellings.
11. Enforce compliance with the laws of this state relating to pollution of the air.
12. Represent the State of Oregon in any and all matters pertaining to plans, procedures or negotiations for interstate compacts in relation to control of air pollution.

According to the Act, the discharge into the air of solids, liquids or gases so as to cause such injury to human, plant or animal life or to property as constitutes a public nuisance is contrary to the public policy of the State of Oregon. Proceedings to abate public nuisances created by pollution of the air may be instituted at

Portland, Oregon, looking north from the roof of the State Office Building, often has this appearance. Photo taken at 8:45 a.m., Sept. 2, 1952.

law or in equity in the name of the State of Oregon, on behalf of the Authority, by the Attorney General.

The Authority has the power to hold hearings, receive complaints and evidence, and issue orders requiring compliance with its rules and regulations and the State Act. Persons, concerns, industries, etc. have the right to be represented by counsel and produce competent evidence pertinent to the matter before the Authority. Appeal of Authority orders may be taken to the Circuit Court.

Activities

The Authority organized on August 24, 1951, elected officers, and embarked upon a program to obtain suitable personnel, basic data, and formulate a cooperative program with industries, cities and others concerned with the complex problems of air pollution control. Standards, rules and regulations will be considered for adoption at a later date after sufficient data and information have been accumulated to warrant the establishment of criteria for the control of emission of air pollutants.

Delay in beginning field and office activities occurred because of difficulty in securing adequately trained personnel to carry on the work of the Authority. Work began in June of this year, and is proceeding with three employees in the central office and with the cooperative assistance of the three District Sanitary Engineers of the State Board of Health located in different sections of the State. Field studies are under way and data is being accumulated about air conditions in several localities within Oregon.

The Authority realizes the complexity of the many problems connected with the reduction and control of smoke, gases, fumes, liquids and particulate matter. The board members and employed personnel expect to accomplish their objectives and carry out their duties in cooperation with all concerned rather than to resort to coercive and primitive procedures. It is believed that many materials and wastes now discharged into the atmosphere can be recovered with profit by many industries, and that better combustion devices and installations and proper operation thereof will not only reduce air pollution but will result in savings in fuel and labor costs. Industry will be expected to solve its own particular problems, but the Authority stands ready to cooperate and assist within the limitations of the funds, personnel, and the law under which the Authority operates.

Look what a brisk wind can do to Portland's scenery! Photo taken at 4 p.m., Sept. 12, 1952.

WINDMILL POWER TESTED IN BRITAIN

A NEW PLAN to save precious coal involves harnessing the winds that blow along England's western coasts. The possible saving is reckoned in millions of tons per year.

The best site for the windmills, according to the North American Newspaper Alliance, will be in Cornwall, Wales, the Isle of Man, Ireland, Western Scotland, and the Orkneys.

A small pilot mill is now undergoing trials on Costa Head, in the Orkneys. Soon another pilot plant will be in action in North Wales.

CHIMNEY SWEEPS BRING GOOD LUCK

ACCORDING to German folklore, chimney sweeps bring good luck, but the men who live by this trade don't agree.

One of the many tests which an apprentice sweep must master, according to the Associated Press, is to be able to climb 90 feet up a sooty chimney measuring only 17 inches in diameter.

Nearly all the chimney sweeps in Western Germany have broken at least one limb, for the job is still highly dangerous in spite of all safety precaution. In addition to this hazard a few decades ago German sweeps also faced odds of contracting skin cancer. However, science has practically eliminated this occupational disease.

The working costume of the sweeps is a black silk hat, a close-fitting black shirt, black trousers, and black shoes. Inside the chimney, they wear masks. They ride from job to job on bicycles, steering with one hand and carrying a short ladder and a wrapped up brush in the other.

Every chimney must be swept eight times a year under the law. These jobs include factory chimneys towering 300 feet or more, and small house chimneys so narrow that the blackfaced men almost need a shoe horn to get in.

Monthly earnings of a meister sweep before taxes average 1,000 marks ($238) —over twice that of a Ruhr coal miner. Each master is responsible for a district which has a specified number of chimneys. There are nearly 3,000 master sweeps in West Germany. Their title: (Germans *love* agglutinization!) *bezirksschornsteinfegermeister.*

WE DON'T HAVE ALL THE ANSWERS!

How the Texas State Department of Health Tackled a Stubborn Air Pollution Condition

BACK IN JUNE a public hearing was conducted in the Baylor Medical School auditorium in Houston, Texas, for the purpose of giving citizens who are concerned with air pollution in Harris County an opportunity to express their views.

These views, quite naturally, pointed the finger at the polluters — industrial firms in the Ship Channel area. Following the spirited hearing, the authorities felt it was only proper to allow industry to tell its story.

Accordingly, another hearing was called for August 20 by Dr. George W. Cox, State Health Officer, to publicize the problems and progress made by industry to date, as well as the plans which are being formulated to minimize present evil conditions.

The testimony of officials and representatives of industry was so interesting that great parts of it are hereby presented as documentary evidence of a history-making event in Texas. The Hon. Bob Casey, County Judge, presided. Here is what some of the guests had to say:

V. M. Ehlers, Director Bureau of Sanitary Engineering Texas State Department of Health Austin, Texas:

I feel most optimistic about solving the air pollution problem here in Harris County since I have had the pleasure of talking to various groups and all of them desire to see that the right things are done. I understand that committees from industry and citizens have been organized and that all that is required now is a "guide" and the mechanics for putting the machinery into operation.

Mr. Burnell Waldrep, Assistant Attorney General Office of the Attorney General Austin, Texas:

Primarily this is not a meeting for a discussion of legal principles relating to air pollution. It is simply a meeting to reconcile our differences and exchange ideas in an effort to solve the problem of air pollution which allegedly exists in Harris County.

Basically, reasonable minds do differ. We have differences of opinion as to how to solve air pollution in Harris County, and particularly in the Ship Channel area, and only in this manner will we be able to adjust these differences.

John D. Richardson Assistant District Attorney Harris County Houston, Texas:

In the past so far our duty has been simply to advise. That is, to advise county officials as to their duties and responsibilities under legislation. In accordance with our advice, we think that certain steps have been taken which indicate great progress has been made in the general condition of air pollution in this county. Investigations have been made by Dr. Farragut's office, and by representatives of the State Department of Health. Those investigations will continue. Investigations are not being made of any one particular industry, but of many industries all along the Ship Channel.

M. D. May Champion Paper and Fibre Co. Pasadena, Texas:

An industrial concern has a responsibility to the community to conduct itself in the manner of a good citizen. This has been the aim of Champion ever since we came to Pasadena.

Pulp mill odor difficulties have plagued the wood pulp industry for many years, and many millions of dollars have gone into research on this particular problem. The Houston Division of the Champion Paper and Fibre Company alone has spent over $1,000,000 in air pollution abatement research and equipment.

We feel that much has been accomplished in this direction over the years, but we also feel that more remains to be done. No efforts are being spared to bring about a final and satisfactory solution to the problem.

The overall problem of a pulp mill consists of two general parts: the fly ash carried in the flue gas from the chemical recovery furnaces, and odors emanating principally from the wood digestion system.

In the pulping process wood is cooked with certain chemicals which solubilize the adhesive material present in wood, thereby freeing the individual wood fibers. These fibers can then be used to make paper. In the course of the cooking or digesting operation, certain side reactions take place which lead to the formation of small amounts of malodorous sulfur organic compounds.

These are the compounds which must be eliminated or converted to some less objectionable form in order to reduce the odor. The primary reaction in the digesting step is between the inorganic, cooking chemicals and lignin, the adhesive which holds the fibers together in wood.

The products of this reaction, being soluble in water, are washed from the fibers after digestion and are sent to a chemical recovery operation. In one step of this recovery operation the reaction products are burned to free the inorganic chemicals from the organic matter which burns away. This is done in recovery furnaces, and these are the sources of fly ash mentioned previously.

Champion has attacked both the fly ash and the odor problems in its air pollution abatement work.

Considering the question of fly ash, Champion pioneered the use of electrical precipitation for fly ash collection in the pulping industry. Electrical precipitation was found to remove 90-95% of the fly ash coming from the furnaces, so units of this type were installed on all of our recovery furnaces at a cost of $465,000.

We are currently engaged in research to find the best means of eliminating the last bit of fly ash which gets by our present precipitators. While on the subject of the effluent from our recovery furnaces, this effluent contains a vast quantity of water vapor or steam formed from water associated with the products being burned. This water vapor comes out of our stacks in clouds and comprises the greatest portion of the visible smog. Another source of dust or fly ash is our lime producing system. To combat this problem, we have installed a rotoclone scrubber on our large lime kiln ot a cost of $40,000.

Considering the odor problem, several beneficial steps have been taken. The malodorous gases formed in the early stages of the cooking operation are vented off, condensed, and the non-condensable gases are destroyed by burning.

In order to explain the other steps taken, I will have to go a little deeper into our operation. The reaction products of digestion contain, among other things, some hydrogen sulfide, sodium sulfide (which will yield hydogen sulfide in the presence of an acid) and mercaptans.

Hydrogen sulfide and the mercaptans, as you perhaps know, are bad smelling. If sodium sulfide is converted into sodium sulfate by oxidation, it does not form hydrogen sulfide. Consequently, we are now oxidizing our spent liquor, the solution of reaction products washed from the pulp, to gain this advantage; this has been done at a cost of $30,000.

The spent liquor after oxidation must be concentrated before it will burn in the recovery furnace. Multiple effect evaporators are used for this purpose. The vapors distilled off in the evaporators contain some hydrogen sulfide.

This is removed from the vapors by scrubbers placed after the evaporator after condensers, which were installed at a cost of $2,000. We are now experimenting with chemical treatment in an effort to further improve our odor situation.

We feel that we have gained considerable ground in our battle with air pollution, but we are no less diligent now for having done so. We have still unanswered problems, but we sincerely hope to find the answers. We pledge our complete cooperation with the state, county and municipal authorities. Indeed, I hope that their technical men may give us added help on the problems that remain to be solved.

W. G. Rouse, Treasurer Mathieson Chemical Corporation Baltimore, Maryland:

I want to bring you a message from the top management of the Mathieson Chemical Company.

We want to do everything that we can to help. All industry is spending a great deal of money in research, and it's a problem that faces us in all communities. We have it in Baltimore. There has been a great deal of money spent there in trying to solve it. The Health Department there has spent a great deal of money in trying to analyze the best solution to the problem.

And in spite of all that, we certainly don't have an answer there, and we have had this problem for many, many years and have built up a very heavy population around our industrial areas because in Baltimore, we're not as fortunate as you people here.

People live in row houses. There are hundreds of thousands of people accumulated in small areas and in those areas there are also the industrial plants because they moved in there to be near the places where they work, just as has happened and is happening in this area.

First, I think it might be interesting for our neighbors to know that we have had the operations of our Pasadena plant for three years. During that three years we have spent over $500,000 on equipment in an effort to reduce the air pollution caused by our plant.

We are spending very large sums of money on research, as are almost all other companies, to determine ways and means of solving this air pollution problem. We don't have the answer. In talking to experts in our own Health Department in Maryland, they haven't found anyone yet that has the answer.

We do own a chemical industry, it does smell, and we're going to try to correct that, and the engineers are working on this problem. They have been working on it for years, and they will continue to work on it.

We have established at the Pasadena plant a pilot plant for which we have great ambitions. We hope that it is going to be a substantial solution. If it works, we will install a plant, if it is practical, and feasible, and will assist.

We have also ordered certain dust filtering equipment. That equipment is very much in demand and there's a long delay in getting it. In order to get that equipment here more quickly we have again solicited the help of the State Health Department, and they are making every effort they can in solving this problem and have agreed to follow up our order which is in the hands of the manufacturer, and request that the manufacturer expedite delivery of that equipment to us.

In the meantime we have on construction at the Pasadena plant a supplementary filter which we expect to have installed sometime during the month of September. We feel that this supplementary equipment will materially reduce the dust that comes from our fertilizer plant.

We hope the steps that we have already taken at our Pasadena plant will justify a feeling on the part of this community that we are being good citizens, that we have recognized our responsibility to our neighbors, as well as to the 400 or 500 families that are dependent upon the operation of our plant for a livelihood.

It is impossible for me to explain the engineering aspects of what we have of our Agricultural Chemical Division, and so I'd like to take this opportunity to call upon the director of operations, Mr. Sam Cottrell, who will explain to you how we have done the things that I have mentioned from a layman's point of view.

INCOME TAX DEDUCTIONS

Membership dues to the Air Pollution Control Association are deductible from income tax, according to a ruling received by the Secretariat in September.

The Office of the Commissioner of Internal Revenue wrote as follows:

"Contributions made to you on and after Jan 1, 1951 are deductible by the donors in computing their taxable net income in the manner and to the extent provided by Section 23 (o) and (q) of the Code.

"Bequests, legacies, devises, or transfers, to or for your use beginning Jan. 1, 1951 are deductible in computing the value of the net estate of a decedent for estate tax purposes in the manner and to the extent provided by sections 812 (d) and 861 (a) (3) of the Code. Gifts of property to you beginning Jan. 1, 1951 are deductibile in computing net gifts for gift tax purpose in the manner and to the extent provided in section 1004 (a) (2) (B) and 1004 (b) (2) and (3) of the Code."

Sam Cottrell
Director of Operations
Agricultural Chemical Division,
Mathieson Chemical Corporation
Pasadena, Texas:

Our plant at Pasadena is primarily a fertilizer manufacturing plant, and the principal raw materials of making fertilizer are phosphate rock, ammonia, potash and sulfuric acid. So we have a sulfuric acid plant there to supply the acid that is needed in our operations.

Sulfuric acid is made by burning sulfur, and through a catalytic process converting that to sulfur trioxide, which is the principal constituent of sulfuric acid. When the plant is operating normally, there is a thin white wisp of smoke coming from the exit stack of the acid plant. Depending upon the atmospheric conditions, it is more or less visible. If the day is damp, you can see it much more plainly than you can on a dry, hot day.

Now, if the plant gets out of adjustment, some of the sulfur trioxide which is reduced will escape from the stack as a dense white fume. There are at least half-a-dozen things which could cause such an emission, and as soon as our operators were aware of what was happening, they immediately went through the plant looking for the things which normally cause such an occurrence.

In order to find out what the cause is, it is necessary to continue the plant in operation. If you shut it down, you can't find out what the trouble is. In the case of the July incident, none of the usual things which cause such an event were the trouble.

What had happened was that some bolts holding internal distributor pipes in an air dryer had broken and were causing improper distribution of the material going through the dryer.

It took some time to discover this because it had never happened in this plant before, and to my knowledge, has never happened in any other plant of similar design. After this was discovered and corrected, the plant was started up, and still the conditions were bad. It was found that the same thing had happened in an absorbing tower connected with the plant.

Phosphate rock is one of the principal ingredients of fertilizer manufacture. The rock has to be ground until it is very fine, and in the grinding operations some rock dust is produced. We have installed dust collecting apparatus at the grinding plant to collect the dust.

None of these things work perfectly, and in spite of the presence of this equipment, some dust continues to escape. The atmosphere in this part of the country being rather humid makes the problem somewhat more difficult, and apparatus which works normally in other climates is less satisfactory here. However, we believe that we have devised ways and means of helping with that situation, and we have equipment on order which we think will improve what we already have.

As recently as the spring of this year some additional dust collecting equipment was installed at our shipping dock were the fertilizer is bagged and where some dust escapes. This, too, is not 100% perfect, and we have ordered some additional filtering equipment which we believe will substantially reduce the dust which escapes.

Phosphate rock is treated with sulfuric acid to make phosphoric acid. Phosphoric acid is combined with ammonia and sulfuric acid and potash to make fertilizer. The phosphoric acid that is produced is too weak for the purpose and has to be concentrated.

At this plant we formerly had a type of evaporator or concentrator which produced a very distinct and annoying fume. That was corrected a year or two ago by the installation of a very different type of evaporative plant at a cost of over $200,000.

At other points in the process where dust and fume are produced and odors, we have installed scrubbing equipment. Our predecessor company had begun the installation of some of these things and we have continued them.

At the time this plant was built most fertilizer plants did very little to control the emission of odors, fumes and dusts, and they were customarily located in isolated areas so that no one would be disturbed. It has been the rule that after a plant has been built in a place such as

All In A Lifetime

A Dog's Life

McNaught Syndicate, Inc.
WE NEED A BUNG STARTER.
I CAN'T BUDGE IT--
LET ME TRY IT.
SHALL I SOUND AN ALARM AND GET THANKS-- OR LET IT BURN AND GET MEAT?
7-8

that, the people who work at the plant like to move near to it so they won't have to drive 20 miles through traffic to get to work. Pretty soon the isolated plant is surrounded by a residential area and something has to be done. In the last three years, since Mathieson has taken over this plant, we have spent upwards of half-a-million dollars for this purpose.

Business has been pretty good at this plant, and we have increased our production, and in order to cope with that situation, we have doubled the amount of scrubbing equipment that was originally installed to take care of the situation.

There are still odors emanating from the plant. As yet, we do not know how to eliminate them entirely. We do have a research program which has been going on for some time.

Even before the plant was built, our predecessor company had conducted research in this field, and there has been a continuing program, both at the Pasadena plant and since Mathieson has taken over at other plant locations, to deal with the problem. We don't have all the answers yet, but as fast as we get them we can assure you we will install equipment to deal with the situation.

Rex G. Baker
Humble Oil and Refining Company
Houston, Texas:

It should be realized that it is impossible to operate oil refineries, chemical plants, paper mills, and many other types of industrial plants without incurring some air pollution. Humble has paid particular attention to the causes of water and air pollution at the Baytown Refinery.

Since the end of the war, the water pollution problem has been stressed with the result that completion of certain treating facilities has produced a water effluent from the refinery of satisfactory quality. Because of the complicated nature of refinery operations and the need for obtaining fundamental information on the sources and types of air pollution and practical means of preventing it, progress pertaining thereto has not yet reached the stage already realized on the reduction of water pollution.

Many measures have been adopted over the past few years at the Baytown Refinery to reduce air pollution. In the last five years alone, these measures have involved a capital expenditure of over $3,000,000.

Our technical and research staff is actively engaged on the problem of air pollution and we are aware of its importance. Consultants from Stanford Research Institute, who were very effective in assisting industries in their efforts to reduce air pollution in the Los Angeles Basin, have been engaged in assisting us in our studies. We will continue to pursue our efforts to reduce air pollution to a practical minimum.

C. E. Lyon
Diamond Alkali Company
Deer Park Works
Houston, Texas:

Industry does not make these smells that we get around the area. God Himself put the smell in the various chemicals; He put the smell in iodoform; He put the smell in onions; no one can take that smell out. All the technical help in the world cannot alter those smells.

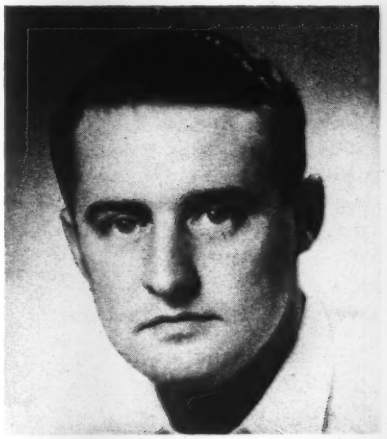
The only thing that industry and their technology can do is to change those compounds into compounds that do not smell. We cannot take the smell out of chlorine, as an example, or out of any other compound that we get. These sulfur compounds, these mercaptans, they all have a natural smell that's there.

No one can take it out. The only approach to that problem is to change that smell over into something that doesn't stink quite so much.

Diamond Alkali bounded on the front page in air pollution matters a short while ago. We had an accident at our plant and released considerable amounts of chlorine gas. Chlorine is a very obnoxious gas. It does bother the mucous membranes of your throat. It is definitely not a poisonous gas.

Our first aid facilities contained some chlorine due to the escaping of gas out there, and we took all of our employees that were affected to the Pasadena Hospital so that they might get oxygen treatment which very much relieves the irritation.

That was primarily the reason why it was spread so much in the newspapers. It wasn't a serious accident at all. All of the folks that went down to the hospital, except five, were released almost immediately after they received preliminary oxygen treatment.



Lawrence A. Crick, who has just been added to the staff of John L. Hodges in Philadelphia, was director of air pollution in the city of Niagara Falls, N. Y., since 1949. The 28-year-old chemical engineer was graduated from Pennsylvania State College and served as a navigator in the U. S. Air Force during World War II.

Five of the ones that seemed to be bothered more than the rest stayed in the hospital over night and were released the following morning. So it was not the question, as was put in the newspaper, that some 300 were gassed and some were killed and the plant was blown up and so on. Quite frequently, accidents in our plant are over-exaggerated in the description of these things.

Any of these plants may be subject at times to accidental conditions. We made 400 tons of chlorine at our plant and do the very best we can in keeping it inside the pipes. But once in a while things get away from you and chlorine does get out.

We're in a fairly fortunate location, physically, so that, to the very best of my knowledge, no one outside of our own employees even smell any chlorine due to the conditions at our plant. But I wanted to point out primarily that conditions of that type can happen in almost any of our plants, and I believe that the citizens, the people of the area, are not particularly critical of these conditions if they feel that the industry is doing what they can within all possible reason to correct those conditions so that they don't occur too frequently.

We welcome visitations in our plant from citizens interested in the operations or in air pollution conditions or stream

pollution conditions. We have visitations from the State Health authorities, and we appreciate that. We have gained a great deal of knowledge from them. We welcome them at any time, and any time that any of the group, technical groups, citizens' groups, would like to come into our plant to take a look at what we do, learn what we do, what our problems are, we welcome them.

E. S. Rothrock
Vice President and General Manager
Consolidated Chemical Industries, Inc.
Houston, Texas:

We have always been cognizant of the fact that air pollution is one of our greatest problems. Now we think that we have succeeded in operating our plants in a manner that is not objectionable to the home owners who live in our neighborhood. At least in recent years we have had no serious complaints.

Now I might say that I have been impressed as the Chairman of the Air Pollution Committee of the Houston Chamber of Commerce. When I say that I did not solicit the job, I am sure that all of you are well aware of that. But we are going to do everything we can to attempt to acquaint home owners and others who are complaining that we are aware of the fact that they have a right to complain. But we hope that they do realize, as has been stated already, that Houston cannot become a great industrial city without air pollution to a certain extent.

C. E. Lyon, Vice Chairman
Industrial Committee on Air and Water Pollution
Houston Chamber of Commerce
Houston, Texas:

We, the Subcommittee on Air Pollution, Industrial Wastes Committee of the Houston Chamber of Commerce, realize that there is an air pollution problem in certain sections of Harris County, and we recommend that corrective action should be taken by individual industrial plants in the area at once.

We believe that industrial plants should evaluate themselves in this matter and effect the desired and necessary results. We urge that periodic meetings of interested parties be held to this end, since we believe that an open discussion of this problem is in accordance with good democratic policies.

This Industrial Pollution Committee of the Houston Chamber of Commerce will cooperate with the industries in this area to further the full cooperation of interested groups of citizens and representatives of health departments, and we urge that all industries in this area advise the State and County health officials regarding any unusual conditions occurring in their plant which may cause an abnormal discharge of pollutants to the atmosphere.

We urge individual industries to conduct air pollution surveys covering the particular condition in their plants and that they exchange technical information with our group and health authorities concerning air pollution control methods.

When the problem of air pollution was very forcefully brought to the attention of industries along the Ship Channel, primarily through the vigorous and intelligent program of the Greens Bayou Pollution Committee, the Houston Chamber of Commerce decided to enlarge its Industrial Pollution Committee to cover the problem of air pollution.

Industry along the Channel had not been entirely asleep as to the seriousness of this problem, nor had it failed to take action to solve the problem. Several millions of dollars had been expended prior to this year by various industries on the Channel in investments to reduce atmospheric pollution.

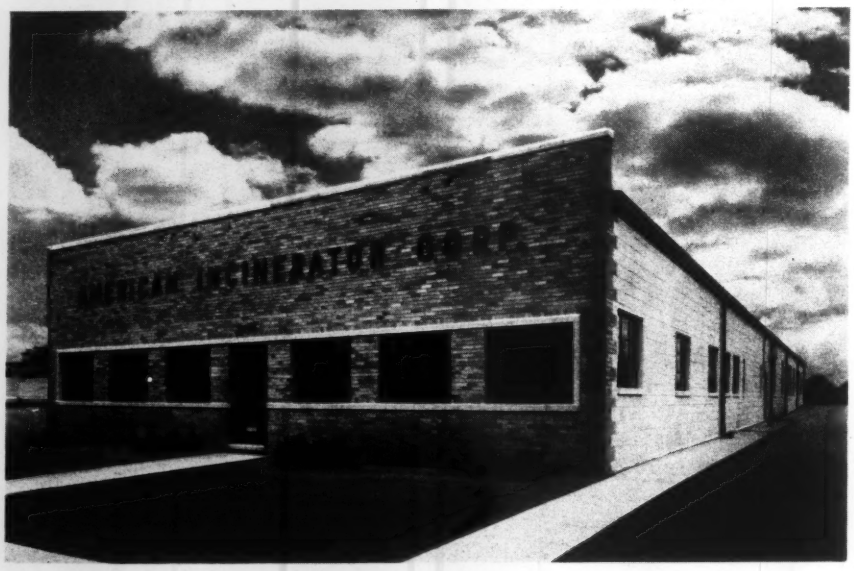
The Air Pollution Committee and the overall policy committee of the Chamber of Commerce on pollution is composed of top executives of the Houston industrial area industries and is made up of men with authority to act on problems presented and made up of men who are not only responsible executives but who are citizens of this Houston area.

The men on this committee are not absentee directors. They are fully aware of their responsibilities to the community from a point of view of health and public relations of their companies in the community, and they are fully aware of the economic problems of our growing industrial area.

The men on this Committee have at their call a large staff of technical personnel—engineers, chemists, physicians, etc.—competent to analyze and advise on the technical problems involved.

This Committee started its work with a questionnaire, as it had started the work on water pollution, to get an indication of the breath and scope of the air pollution problem. The preliminary study of the question showed that questionnaires should be sent to some 1300

This is the attractive new building housing the American Incinerator Corporation's factory and offices at 5710 E. Nevada Avenue, Detroit 34, Mich. The 11,000 sq. ft. of building space is on a 24,000 sq. ft. site, able to accommodate further expansion when necessary.



industries in the Houston and Ship Channel area.

The question of air pollution is not a question of one or two or three companies. It is a question of the operations of many hundreds of companies in our area.

The air pollution problem is, of course, a much broader and more difficult one to handle than water pollution. Domestic wastes from our homes and offices are largely handled through our municipal sewage systems. There is no provision and can be no provision for the tremendous amout of air pollution from several hundred thousand automobile exhausts.

There is no provision and seemingly can be no provision for the air pollution from thousands of home incinerators. There is, of course, air pollution from every gas heater and gas furnace in the homes and offices in this or any other area where such heat is used. The question of air pollution therefore is not one that can be solved completely. There will always, as long as there are people in an area, be some measure of air pollution.

What we in the Industrial Air Pollution Committee of the Chamber of Commerce are trying to do is to enlist the cooperation of industry in minimizing as far as is technically and economically possible, the offensive pollution of the atmosphere around our cities.

Industrial air pollution can never be entirely eliminated if we are to have industry. If we have no industry, we have no Houston, or Harris County Industrial Development Area. It is technically impossible to eliminate all air pollution by industry. It is economically impossible to eliminate all air pollution even where it is technically possible to eliminate this pollution. This does not mean that industry is not spending and should not spend necessary funds to reduce as far as is possible, and as far as is practical, the contamination of the atmosphere.

We think that insofar as technical solutions are possible and insofar as these technical solutions can be applied without the elimination of the industry through economic pressure, they should be applied.

We think that air pollution hazardous to life and injurious to health must be eliminated regardless of cost.

The Chamber of Commerce Committee on Air Pollution has no police powers and the Water Pollution Committee had no police powers. We think, though, that by jointly analyzing situations facing us and by constructive criticisms of our industrial neighbors that we can and will show that industry can solve its own problems.

We feel that no more laws are necessary to solve this question of air pollution. We feel that litigation is not the answer until and unless other methods have proven inadequate.

A great percentage of the industries in this area are companies which are new in this area. In most cases they represent the finest developments of technical skill in their particular industries. This is logical and understandable because they are the development in their particular industries. We have in this area very few old, outmoded plants, very few plants built without the advantage of recent technical developments and technical skills.

Where operations produce some measure of air contamination and where such contamination is not injurious to health and where such contamination is the result of defense work for which there is no substitute, then we think the citizens of the area will be charitable in their criticisms of industry.

However, where the conditions are brought about solely by the desire of particular industries to make money at the expense of the community, we think such industries should be prepared to "clean house" or suffer the consequences.

In introducing industry's side of this question to you, we believe you first should know that industry is making a definite, serious, honest and cooperative effort to solve this problem which affects the executives, managers, owners and employees of industries and which affects all the citizens of the community. Many of these citizens, incidentally, are the managers, employees, and owners of these same industries.

Houston and Harris County industries have played a tremendous part in improving our living conditions here and all over the country because of the vital products made in this area, such as more, better and cheaper gasoline; synthetic rubber, ethyl gasoline fluids; plastics of all kinds; fertilizers; paper; insecticides. Our industries are vital to this area and to the nation in maintaining our mode of living, all of this in addition to the millions of dollars of construction and operations payrolls.

It is the opinion of our Committee that industry must and will accept the challenge of air pollution, face it squarely, make the necessary extensive surveys, purchase necessary equipment to correct the present air pollution condition in the area; and I believe when I make this statement, that I voice the general opinion of the industrial management of this area.

It is the opinion of our Committee that industry must and will continue to cooperate with the State and County Health authorities or any public-spirited industrial or citizens groups interested in this problem. We invite open discussion of this problem in our efforts to learn more about the problems and definitely invite constructive and friendly criticism.

We believe that industry as a whole has no patience, and will have no patience with those units of industry which are thoughtless of the welfare of the people who live in this great area. We will cooperate with any one in the solution of our problem. We will help any industry, if we can, in the solution of our problems. We will not defend in any manner any industry that thoughtlessly or deliberately imposes upon us, as industries operating here, or on our employees and friends living in this area.

V. V. Henrich, Vice President Rohm and Haas Company Pasadena, Texas:

Our company cannot say, like Humble, that we have spent $4,000,000. $4,000,000 probably would break us. We're one of the smaller boys along the Ship Channel. But small or not, we recognize that we could become a big nuisance. When our plant was established and started operations in 1948, we recognized that there were certain gases which we would give off to the atmosphere which would be bad. We sent them through a flare stack and destroyed them by heat so that the result is that practically all of our off gases are carbon dioxide.

Several years ago our research department started to develop a new process. This process had some toxic materials in one portion of the equipment. We developed, in conjunction with some of the larger instrument companies in the country, detecting devices to detect concentrations of this material, should it leak out of the pipes in which it belongs, if present at a concentration of .01%.

This was largely for the protection of our employees. Now then, if any infinitesimal amount of this material would get out into the room and out of the pipe, we asked ourselves, "What are we going to do about it? Shall we just blow it up a stack, even though it might be a very small quantity?" It might not be good.

Fortunately for us, this material had the property of being decomposed at a very, very low temperature, approximately 100°C., the boiling point of water. So our ventilating systems all have relief valves anywhere that this toxic gas may be present to draw it into a decontaminating furnace in which there is a constantly burning flame to destroy any small portion of toxic gases that may be escaping from any point.

I tell you these things to make you aware that we in industry have terrific problems. We are interested in solving them. We want to solve them. The instruments that I was mentioning to you a few minutes ago took us two years to perfect. In research and purchase of the instruments we spent something close to $100,000.

It contributes nothing to our production. It only adds to our cost, but we feel that even if we save one life over a period of the next 10 years, or 20 years, that investment is worthwhile.

This decontamination furnace that I was talking to you about was put in at a cost of $35,000. That, too, adds nothing to production. But I wish to impress upon you that we in industry are aware that if we wish to continue to exist in our expanding society we have to pay attention to our employees and the public around us.

Boyd N. Hill, Vice Chairman Cooperative Air Pollution Committee Baytown, Texas:

It is most gratifying to see all of these large figures industry has spent towards air pollution and water pollution, and I think that they deserve a great deal of credit. Nevertheless, I think they have all admitted that there is a great deal to be done still.

I will say this, though, that I have been in this community for some 22 or 23 years, and I'm a scientist myself. I know some of the problems of industry, and also appreciate those problems. We know that the development of this area is greatly responsible to industry.

However, there comes a time when there must be something done, and this problem of air pollution has prevailed for some time and has continued to grow worse since 1940. It was excusable during wartime because of the critical period we were in. But certainly, I don't think industry has shown the right diligence since that time towards correcting these measures.

I have heard a lot about how much they have spent. I have heard no figures about what they are polluting the air with in quantities. Those might be astounding. I am saying this because I am sure that as I go back through Greens Bayou or around any other industrial plant, I'm going to be aware that the pollution is still there.

We are desiring to see industry not say how much have we done, but how much are we doing now, and are we going to correct it. It doesn't make any difference if you correct your air pollution 85%, the other 15% still comes under the nuisance situation. There's still something to be done.

CASE HOLDS SYMPOSIUM

The first organized effort to study atmospheric pollution control for the chemical industry by Case Institute of Technology will be held in Cleveland November 10, 11, and 12.

George W. Blum, assistant professor of chemical engineering, will preside over the opening session. After a welcome by Dr. Elmer Hutchisson, Acting President, Dr. William von Fischer, head of the Department of Chemistry and Chemical Engineering, will make the introductory remarks.

E. L. Worthington, Director of Public Health and Welfare, City of Cleveland, will speak on *Problems in Plant Location and Municipal Control of Dust and Fumes.*

Other speakers the first day include W. L. Wilson, Chief of the Bureau of Industrial Hygiene, City of Cleveland, who will speak on *Dilution Ventilation for the Control of Air Contaminants.* He follows H. C. Cutter, industrial hygiene engineer of the City of Cleveland, who will speak on *Industrial Ventilation, Ducts, Exhausts, and Fans.*

W. C. L. Hemeon, Director of Engineering, Industrial Hygiene Foundation, Pittsburgh, will speak on *Stack Dusts—Problems in Measurement of Quantity and Particle Size.*

Medical Aspects of Occupational Hazards is the subject chosen by Dr. H. S. Vanordstrand, of the Cleveland Clinic, for Tuesday morning's meeting. *Know Your Hazards—Industrial Case Histories,* by Lester Merritt, industrial hygiene engineer of the Ohio Industrial Commission, Columbus, will follow.

G. A. Howell, assistant to the chief engineer, U. S. Steel Company, Pittsburgh, will speak on *Air Pollution Control in the Ferrous Industries,* followed by W. E. McCormick, chief industrial hygienist, B. F. Goodrich Company, Akron, O. who will speak on *Control of Solvents and Liquid Pollutants.*

Keynote address of the symposium will be delivered at the banquet Tuesday evening by Mathew M. V. Braidech, Director of Research, National Board of Fire Underwriters, who will speak on *Cooperation of Industry, Government and Science in Community Problems.*

John M. Kane, American Air Filter Company, Louisville, will speak on *Equipment and Methods of Evaluation for Dust Control,* followed by H. B. Wilson, project engineer, Brown-Lipe-Chapin Division, General Motors Corporation, Syracuse, whose subject will be *Air Pollution Control in the Electro-Plating Industries.*

The Houdry process, which has caught the nation's attention because of recent publicity in LIFE, TIME, and AIR REPAIR, will be explained by William Bowen, chief engineer, Oxy-Catalyst Manufacturing Company, Wayne, Pa. His subject is *Catalytic Combustion of Atmospheric Fumes.*

Wind-up speaker for Wednesday is Robert T. Griebling, Executive Secretary, Air Pollution Control Association, who chose as his subject *Cleaning Our Air*. He will dwell on the rapid growth of the Association and its immediate plans for the future.

New Haven Air Pollution Survey Completed

IN THE SUMMER months all areas of the city of New Haven, Conn., are as clean as the typical suburban areas of any American city.

And there are few cities of comparable industrial activity whose winter dustfall is as low as that of New Haven. As a matter of fact, the dustfall in most cities embracing heavy industry is very much greater.

These are some of the facts brought out by the Industrial Hygiene Foundation, which completed a one-year survey of New Haven recently. The report was written by W. C. L. Hemeon, the Foundation's Director of Engineering, and entitled *The Nature of the Air Pollution Problem in the City of New Haven.*

The survey was made after there was a difference of opinion within the Board of Aldermen concerning the need for an air pollution control ordinance and the proper form of such a law.

The basic conceptions underlying the design of the survey are these:

1. The need for regulatory measures cannot be determined by scientific measurements alone. The question can, however, be effectively illuminated for intelligent consideration when pertinent data are provided by various measurements. Assembly of such data would therefore constitute a prime objective of this study.

2. In general, there is no known relationship between health and air pollution. The problem is rather one of nuisance and since there is no absolute definition of nuisance, it will be important in this survey to obtain data leading to significant comparisons.

3. Development of knowledge is needed concerning the origins and relative importance of existing air pollution in the city, and, in the case of emissions from chimneys, an evaluation of the problem of elimination in terms of what is practically attainable.

In accordance with these principles, a study was made of the city industries and fuel burning equipment, and an inventory of stack emissions compiled. Measurements over a period of eight months were made of dust in various sections of the city, and comparisons prepared showing the relative dust between different neighborhoods and between New Haven and other cities.

On the basis of the data provided by dust measurements and the chemical analysis of city soot, an estimate is made of the proportions originating from different sources.

In commenting on the report, Mr. Hemeon wrote to Eric W. Mood, Director of the Bureau of Environmental Sanitation, New Haven, that he felt impelled "to draw a sharp distinction between objective fact which is within the province of such a survey, and subjective opinion which is not."

General conclusions drawn by Mr. Hemeon include:

Fuel Dust and Smoke. The weight of evidence from the various methods of analysis applied to the question indicates that the contribution to dustfall in the city due to tall industrial chimneys is, conservatively, not over 20 to 25 percent in cold weather. In the summer months it might account for 30 to 35 percent, at most.

Regulation of emission of fuel dust in accordance with standards of good industrial practice, as outlined in the ordinance provisions in the following section would, on the basis of the stack inventory estimates, reduce dust emissions by 50 percent. This means that in terms of dustfall at ground level an overall reduction of 10 to 15 percent is the best that could be expected by strict enforcement of such a provision.

The tall chimney qualification in the preceding discussion permits the assumption that there are local areas in the vicinity of short stacks that are exposed to materially higher than average dustfall. This must be based on reasonable surmise since it was not practical in this survey to make measurements in a number of subdivisions of each district.

The findings on vanadium content of dust samples supports the conclusion that stack emissions from burning of No. 6 fuel oil (without particular qualification as to stack height) represent a small contribution by weight, of total city dust, but a high proportion of the carbon.

This means that a large scale improvement in combustion of this fuel would tend toward elimination of the objectionable black soot fraction, although no appreciable reduction in total weight of dustfall should result.

"In view of the relatively low dustfall in New Haven as herein stated it is appropriate at this point to re-examine the basis for the dissatisfaction of some of the citizens which led to this investigation.

"We have been increasingly persuaded by the facts cited that the primary problem may well be in the black ingredients of the dustfall. On this presumption, measures which affected a reduction in blackness of the dustfall (even though accompanied by inappreciable reduction in total dustfall weight) would be noted as an improvement by citizens.

"Heavy fuel oil contains a small residue of relatively coarse particles of petroleum coke which burns with difficulty even in conditions of efficient combustion. These particles, however, contribute little to the visible blackness of a smoke plume in comparison with the avoidable smoke often seen issuing from such stacks.

"Such oil also contains a very small proportion of incombustible ash of which vanadium is an important constituent. In effective combustion conditions this residue is perceptible as a white smoke and in the present state of technology is unavoidable. In any case it is not regarded as an important aspect of the problem.

"It is concluded that the most important single cause of the dust reaching ground level in residential areas is in the combustion of heavy fuel oil.

"Dust from such stacks consists mainly of carbon in the form of petroleum coke and carbonaceous solids (soot), the latter resulting from inefficient combustion of the oil itself. The weight of solids emission from such stacks is well below the standards of best industrial practice.

"Improved combustion conditions which minimize visible smoke can be expected to reduce the soot content of dustfall but not reduce appreciably the total bulk of dustfall in the city."

Copies of the report are available on request from Eric W. Mood, Health Department, City Hall, New Haven, Conn.

POINT OF VIEW

by W. C. L. HEMEON
Director of Engineering
Industrial Hygiene Foundation

THERE IS A widespread difference of opinion among smoke control officials concerning the significance and value of dustfall measurements. In our opinion there can be no question about the importance of this measurement provided one recognizes it for what it is, i. e., a quantitative indication of the average weight of large particles raining out of the atmosphere onto horizontal surfaces at a particular location.

It is often alleged that it does not give a true index of a city's "smoke" problem and does not therefore properly reflect improvements in smoke abatement.

This, in our opinion, expresses a misconception concerning the basic difference in both origin and character of fuel smoke, on the one hand, and fuel (or other) dust, on the other. They are two different problems requiring two different methods of detection and two different kinds of corrective measures.

Great progress has been made over the years in the abatement of fuel smoke. Yet fuel smoke has never been routinely measured in American cities and, therefore, no record exists to show the improvements effected.

Education in stack emissions of fuel dust, on the other hand, has lagged in most cities, and where this is true it is reflected in unchanging dustfall figures.

In a word, abatement activities have concentrated on black smoke, while records have been kept only of the fuel dustfall on the causes of which less effort has been expended.

Another point frequently and properly emphasized is that comparison of dustfall rate between different cities is not permissible. The most important bar to valid comparisons is in the failure to classify and average dustfall figures according to the types of districts in which they were obtained.

It is quite impractical in any city to obtain a true citywide average; it would require an astronomical number of measurement locations. It is practical, however to obtain a fair approximation to the average for a particular type of district.

These points are effectively emphasized in a report by Fred R. Rehm of the Milwaukee Department of Smoke Regulation ("First Annual Report of Deposits of Air-Borne Solids in the County of Milwaukee, from July, 1950 to July, 1951).

Milwaukee operates 60 dustfall stations in the County, classified according to the character of the district. The average yearly dustfall when so classified gives valuable meaning to the results.

Following are the year-long averages reported in tons per square mile per month: agricultural zone—16, residential—22, local business—37,commercial and light manufacturing—50, industrial —85. The fallacy of citywide averages is effectively exposed by Rehm in a discussion of these results.

As everyone knows, dustfall figures fluctuate widely in consecutive months. It will be found that if results are averaged for the several months of a single season (and for particular types of districts), these fluctuations dissolve and remarkably stable figures of high significance result.

We felt that by calculating averages according to this system it should be possible to make valid and useful comparisons between cities, provided also that the jar exposure procedures and weight evaluation methods were reasonably similar. To explore this we recently canvassed the smoke regulation officials of a number of cities and encountered a distressing lack of data or of interest in the subject.

We were, however, able to acquire enough comparable data from a few cities which we think effectively demonstrate the validity of the comparison procedure. The following figures (employed in a recently completed report to the City of New Haven, Conn.*) describes relative dustfall in two types of districts for the winter season, defined herein as January to March, and summer, which includes June through Aug.

	New Haven	Amherst	Milwaukee	Seattle
winter (suburban)	18	15	12	9-12
summer (suburban)	8	10	15	10-15
			Holyoke	
winter (city residential)	18	33	21	—
summer (city residential)	11	15	21	—

There are a number of details that could well be worked out by group action within the Association to make dustfall measurements more widely useful.

*See preceding page.

Volcano proves there is no such thing as pure air on the earth. Didicas, a newly risen volcano 38 miles north of the Philippine island of Luzon, pours out a dense cloud of effluent. When the volcanic island was discovered last March, it was five acres in size. Three months later it had grown to 600 acres.—Wide World Photo.

HERBERT G. DYKTOR

In Memoriam

by Robert T. Griebling, A Friend

DEATH, even when anticipated, is never quite bearable. It comes as a rude shock which always leaves its mark.

There was so much for Herb Dyktor to live for—there were so many places where he was needed—that his passing is being deeply felt not only by his family and immediate friends, but by a wide and loyal circle spanning two continents.

Herb covered himself with distinction on many occasions, He was controversial, but only because he was eager to get things done—and in the fields of air pollution and industrial hygiene there are still so many things to do, as all of us know.

But his was also the kind of controversial nature which made and kept friends, and this was one of his main assets. He seemed destined to go very much farther than the important position he held in the councils of the City of Cleveland, and it is a pity that his career was so brutally interrupted. These are the things one faces in life that are so incomprehensible.

The Commissioner of the Cleveland Division of Air Pollution Control, one of the most colorful members of our Association, died October 4 after an illness lasting almost all summer. He was in wonderful spirits during the Cleveland Annual Meeting, whose success was so much due to him, that luckily a great number of us will have many pleasant memories of him.

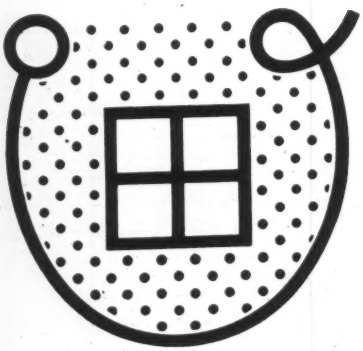
Herb Dyktor was born in Nice, France, of Dutch parentage, and received his education there as well as in Belgium, Austria, and England. He studied in England at the London Polytechnic Institute, from which he was graduated in time to serve in the British Army during World War I.

After the war, Herb was active in engineering in England. Then he came to the States, where he first worked with his brother in the steel business in New York. In 1931 he was offered the position of Chief Industrial Hygiene Engineer of the State of Missouri, and he went west to occupy his headquarters in St. Louis.

Eight years later Herb was offered the same position by the State of Michigan. He accepted and held this position for five years, then came to Cleveland to organize the Bureau of Industrial Hygiene. In 1946 he was asked to reorganize the existing smoke control service. After passage of the necessary legislation in July 1947, he became Cleveland's first Commissioner of the Division of Air Pollution Control.

He was a member of ASHVE, and served on the steering committee of ASME. He wrote numerous articles on industrial hygiene and air pollution, and was chairman of many national technical committees.

Herb Dyktor was a past president of the American Conference of Governmental Industrial Hygienists, as well as chairman of the industrial hygiene section of the American Public Health Association.

His other professional memberships include the American Industrial Hygiene Association, the Conference of Municipal Public Health Engineers, and the national, state, and local Society of Professional Engineers.

To his family and friends the Air Pollution Control Association expresses its deepest regret at his most untimely passing.